Original Article

Factors Influencing Hearing Disability and Reduction in Disability among First-time Hearing Aid Users in Singapore

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Abstract

Introduction: This study aims to examine the factors associated with self-reported hearing disability and early reduction in disability after first-time hearing aid (HA) fitting in Singapore.

Methods: Retrospective record review of 1,068 subjects issued with HAs at a tertiary hospital from 2001 to 2013.

Results: Subjects reporting ≥ 5 disabilities reduced from 90% to 24% after HA fitting. 'Difficulty hearing in noise' was the commonest disability before and after HA fitting, while 'needs to increase volume of TV/radio' was the disability with most improvement after fitting. In multivariable models, having worse pure tone audiometry (PTA) thresholds of the better hearing ear and being ethnically Chinese were associated with subjects reporting more hearing disabilities. A higher proportion of subjects reported a reduction rather than an absence of disability after HA fitting. In multivariable models, daily HA usage for ≥ 4 hours, sensorineural hearing loss (HL) and worse PTA thresholds of the better hearing ear were associated with reduction in more disabilities after HA fitting.

Conclusion: Hearing disability is high among first-time HA users in Singapore. Ethnicity and PTA thresholds were associated with self-reported hearing disability. After HA fitting, higher daily HA usage, sensorineural HL, and worse PTA thresholds of the better hearing ear were associated with early reduction in disability. Patient counselling on the benefits of HL rehabilitation could focus on hearing disability rather than PTA thresholds. The management of patients' expectations could focus on reducing rather than eliminating disability.

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Introduction

The World Health Organization estimates that over 5% of the world's population suffers from disabling hearing loss (HL), defined as better hearing ear pure tone audiometry (PTA) thresholds of >40dB.[1] The 2016 Global Burden of Disease study ranked HL as the third leading cause of years lived with disability globally.[2]

Impairment refers to the reduction in function of an organ while disability describes its impact on day-to-day activities. Handicap refers to the disadvantages encountered by individuals in fulfilling their normal roles.[3] Untreated hearing impairment can lead to hearing disability like communication and sound localisation difficulties. Hearing handicap includes education disadvantage,[4] under-employment and unemployment,[5,6] and impaired social relationships.[7-9] Hearing aid (HA) use is associated with improved social functioning and employment opportunities,[6] improved cognition[10] and lower depression risks.[11]

Self-reported hearing disabilities may be better than PTA thresholds in predicting HA uptake,[12,13] use, satisfaction[10,14] and benefits.[15] In spite of Singapore's

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standing as a high income nation,[16] the 2010 Singapore National Health survey found that only 3.3% of adults with disabling HL use HAs.[17] This compares unfavourably with other developed countries: 14.1% in Japan,[18] 14.3% in the US,[19] 18.4% in Taiwan,[20] and 38.6% in the UK.[21] Singaporeans seek help only when HL is advanced.[22] Only 36% of HA users reported daily usage of >7 hours,[22] compared to the UK (52),[21] Switzerland (57%)[23] and Germany (58%).[24]

Evaluation of the benefits of HA is challenging. A review comparing speech tests with patient questionnaires concluded that speech tests may not represent benefits experienced in a real-world listening environment.[25] Findings from questionnaires, such as the commonly used Hearing Handicap Inventory for the Elderly (HHIE) before and after HA fitting may be limited by errors in captured changes in benefits.[25]

This study was performed to answer the following questions: (1) what are the hearing disabilities and how severe are they in Singapore; (2) to what extent does HA usage reduce hearing disability; and (3) what are the factors associated with hearing disability and reduction in hearing disability.

Methods

Design

A retrospective record review of consecutive first-time HA users at Tan Tock Seng Hospital in Singapore between 2001 and 2013 was performed.

Setting

Patients with suspected hearing impairment underwent a diagnostic PTA. Those motivated to improve their hearing were given a hearing aid evaluation (HAE) appointment, followed by a hearing aid fitting appointment, and a post-hearing aid fitting (PHAF) appointment at least 1 month later, carried out by audiologists using standardised protocols.

The Client Orientated Scale of Improvement (COSI), which allows patients to nominate 5 listening situations in which they need help, was shown to be as accurate as the traditional and longer questionnaires in quantifying hearing disability.[25] Using the COSI methodology, a list of the 8 commonest self-reported hearing disabilities was compiled, facilitating the identification, quantification and management of each patient's hearing disability profile. These questions were routinely administered before HAE and after HA fitting (PHAF), facilitating the evaluation of early changes in disabilities.

Questions 1 to 7 (Table 1) rated the level of difficulty with conversation, hearing and function as 'always',

'sometimes' or 'never'. For question 8, 'hearing loss limits social life', the level of difficulty was indicated as 'severe', 'moderate', 'slightly' or 'never'. This response scale captures the level of individual disability in finer granularity in comparison to a binary 'yes/no' response. However, all 'never' answers were delineated as 'no' and all other answers were delineated as 'yes' to facilitate data analyses for hearing disability before and after HA fitting (Table 1).

Subjects who chose not to answer were categorised as 'non-responders' for the corresponding question. Subjects had the option of answering 'not applicable' to 'hearing loss affects job' and 'family member feels frustrated' (questions 6 and 7).

When analysing the change in hearing disability, a reduction was defined as a change in response on the scale towards improvement at PHAF (e.g. 'always' to 'sometimes', or 'moderate' to 'slightly'). Absence of a reduction was defined as no change at PHAF or changes on the scale towards deterioration.

HL was determined by the 4 tone average hearing thresholds at 0.5, 1, 2 and 4kHz tested independently for each ear. This study was approved by the Institutional Review Board (2013/00325). Waiver of consent was granted as data were anonymised and aggregated for analyses.

Statistical analysis

Statistical analyses were performed using Stata (version 13.1, StataCorp LP, College Station, US). Significance tests were two-sided at the 5% significance level. Categorical data were compared using the chi-square test or Fisher's exact test. Continuous data were compared using the t-test and analysis of variance (ANOVA, normally distributed) or the Mann-Whitney U test and Kruskal-Wallis test (skewed). Results were reported as count (n) and percentage by category for categorical data; mean, standard deviation (SD) or median; and interquartile range (IQR) for continuous data. Bonferroni correction was done for multiple comparisons for each type of difficulty at baseline and follow-up. Factors associated with hearing disability and reduction in disability were evaluated using logistic regression models. The crude odds ratio (OR) and adjusted odds ratio (AOR) are reported with the 95% confidence interval (CI).

Results

Of the 1,068 subjects, 92.3% responded to at least 1 question at HAE (baseline), 73.7% responded to at least 1 question at PHAF (follow-up), and 71.3% had at least 1 valid response for both. The median time from

HAE to PHAF appointment was 2 months (IQR 1 month). For the cohort with mean age of 70 years, 78% of subjects responded 'not applicable' to 'hearing loss affects job' (Singapore's retirement age is 62 years old).

The commonest disabilities where deterioration was reported were 'difficulty hearing in noise' (98.6%), 'difficulty with group conversation in quiet' (97.4%), and 'needs to increase volume of TV/radio' (95.1%). The commonest residual disabilities at PHAF were 'difficulty hearing in noise' (67.5%), 'difficulty hearing over the telephone' (47.4%), and 'difficulty with group conversation in quiet' (44.9%) (Table 1).

The commonest disabilities with reported reduction were 'needs to increase volume of TV/radio' (84.0%), 'difficulty with group conversation in quiet' (81.7%) and 'difficulty with 1:1 conversation' (78.9%), while the least reported was 'family member feels frustrated' (62.0%). Subjects who reported a reduction in disability included those with or without any residual disability.

Baseline disability was high with 90.2% reporting ≥5 disabilities and 58.5% reporting ≥7 disabilities. After HA fitting, the proportion dropped to 24.0% and 6.6%, respectively. Conversely, only 1.7% of subjects had ≤2 disabilities at baseline but this increased to 53.1% after HA fitting.

The commonest disabilities where deterioration was reported were 'difficulty hearing over the telephone' (5.7%), followed by 'hearing loss limits social life' (4.9%) and 'family member feels frustrated' (3.9%).

Comparison of responders and non-responders

Of the 1,068 subjects, 79.1% responded to all 8 questions at HAE, and 64.3% responded to all 8 questions at both HAE and PHAF. Responders and non-responders were compared to assess for any responder bias. Non-response was not question-specific and ranged from 8.1–12.6% for HAE, and 27.3–30.9% for both HAE and PHAF.

Compared to HAE responders, non-responders had more bilateral fitting (16.9% versus 24.2%, P=0.006), but paid for HAs that cost less. Compared with responders for both HAE and PHAF, non-responders were more often fitted with in-ear custom HA, but paid for HAs that cost less (Table 2). No other significant difference was observed. Based on these results, we expect non-responder bias to be minimal.

Baseline hearing disability at HAE

Subjects reporting more disabilities were older with worse PTA thresholds, and subsequently had higher daily usage (Table 3).

Table 1. Hearing disability before HAE and PHAF

Type of disability assessed in each question	Hearing disability before HA fitting (baseline at HAE)			Hearing disability after HA fitting (follow-up at PHAF)			Reduction* in hearing disability		
	Yes	No	Total	Yes	No	Total	Yes	No	Total
1. Difficulty with 1:1 conversation, n (%)	847 (86.3)	134 (13.7)	981	161 (20.8)	612 (79.2)	773	604 (78.9)	161 (21.1)	765
2. Difficulty with group conversation in quiet, n (%)	955 (97.4)	25 (2.6)	980	350 (44.9)	429 (55.1)	779	628 (81.7)	141 (18.3)	769
3. Difficulty hearing in noise, n (%)	961 (98.6)	14 (1.4)	975	519 (67.5)	250 (32.5)	769	591 (78.2)	165 (21.8)	756
4. Difficulty hearing over the telephone, n (%)	840 (87.0)	126 (13.0)	966	318 (47.4)	353 (52.6)	671	459 (70.3)	194 (29.7)	653
5. Needs to increase volume of TV/radio, n (%)	887 (95.1)	46 (4.9)	933	252 (38.1)	409 (61.9)	661	532 (84.0)	101 (16.0)	633
6. Hearing loss affects job, n (%)	192 (88.9)	24 (11.1)	216	40 (25.8)	115 (74.2)	155	71 (68.9)	32 (31.1)	103
7. Family member feels frustrated, n (%)	720 (74.0)	197 (20.2)	917	161 (20.6)	560 (71.7)	721	417 (62.0)	255 (38.0)	672
8. Hearing loss limits social life, n (%)	797 (81.7)	178 (18.3)	975	333 (42.6)	448 (57.4)	781	536 (69.9)	231 (30.1)	767

HA: hearing aid; HAE: hearing aid evaluation; PHAF: post-hearing aid fitting
*Reduction refers to a change in the scale towards improvement

Table 2. Characteristics of responders and non-responders to HAE and PHAF questionnaires (total n=1,068)

	Responder to HAE	Non-responder to HAE	P value	Responder to HAE & PHAF	Non-responder to HAE & PHAF	P value
All questions, n (%)	845 (79.1)	223 (20.9)	–	687 (64.3)	381 (35.7)	–
Question specific response rates:						
1. Difficulty with 1:1 conversation in quiet, n (%)	981 (91.9)	87 (8.1)		776 (72.7)	292 (27.3)	
2. Difficulty with group conversation in quiet, n (%)	980 (91.8)	88 (8.2)		773 (72.4)	295 (27.6)	
3. Difficulty hearing in noise, n (%)	975 (91.3)	93 (8.7)		766 (71.7)	302 (28.3)	
4. Difficulty hearing over the telephone, n (%)	966 (90.4)	102 (9.6)		749 (70.1)	319 (29.9)	
5. Needs to increase volume of TV/radio, n (%)	933 (87.4)	135 (12.6)		738 (69.1)	330 (30.9)	
6. Hearing loss affects job, n (%)	977 (91.5)	91 (8.5)		770 (72.1)	298 (27.9)	
7. Family member feels frustrated, n (%)	973 (91.1)	95 (8.9)		763 (71.4)	305 (28.6)	
8. Hearing loss limits social life, n (%)	975 (91.3)	93 (8.7)		767 (71.8)	301 (28.2)	
Gender, n (%) Male	427 (50.5)	116 (52.0)	0.639	347 (50.5)	196 (51.4)	0.77
Female	418 (49.5)	107 (48.0)		340 (49.5)	185 (48.6)	
Ethnicity, n (%) Chinese	734 (86.9)	195 (87.4)	0.944*	605 (88.1)	324 (85.0)	0.505
Malay	38 (4.5)	10 (4.5)		27 (3.9)	21 (5.5)	
Indian	51 (6.0)	14 (6.3)		40 (5.8)	25 (6.6)	
Others	22 (2.6)	4 (1.8)		15 (2.2)	11 (2.9)	
Age at first HA fitting, years Mean (SD)	71 (13)	69 (12)	0.105	71 (13)	70 (14)	0.133
HL pattern, n (%) Symmetrical	585 (69.2)	160 (71.7)	0.466	478 (69.6)	267 (70.1)	0.864
Asymmetrical	260 (30.8)	63 (28.3)		209 (30.4)	114 (29.9)	
PTA aided ear, dB Median (IQR)	61.9 (17.5)	62.5 (17.5)	0.611	62.5 (16.3)	62.5 (18.2)	0.984
PTA better ear, dB Median (IQR)	56.3 (16.2)	57.5 (17.5)	0.746	56.3 (16.2)	56.3 (17.5)	0.868
HL aided ear,† n (%) Mild	34 (4.0)	6 (2.7)	0.639	28 (4.1)	12 (3.1)	0.724
Moderate	595 (70.4)	158 (70.8)		481 (70.0)	272 (71.4)	
Severe	216 (25.6)	59 (26.5)		178 (25.9)	97 (25.5)	

BTE: behind the ear; CIC: completely in the canal; HA: hearing aid; HAE: hearing aid evaluation; HL: hearing loss; IQR: interquartile range; ITC: in the canal; ITE: in the ear; PHAF: post-hearing aid fitting; PTA: pure tone audiometry; SD: standard deviation;
RIC: receiver in canal; SD: standard deviation; SGD: Singapore dollar
* Using Fisher's exact test.
† Mild (≤40dB), Moderate (>40–70dB), Severe (>70dB).

Table 2. Characteristics of responders and non-responders to HAE and PHAF questionnaires (total n=1,068) (Cont'd)

		Responder to HAE	Non-responder to HAE	P value	Responder to HAE & PHAF	Non-responder to HAE & PHAF	P value
HL better ear,[†] n (%)	Mild	92 (10.9)	21 (9.4)	0.680	74 (10.8)	39 (10.2)	0.693
	Moderate	625 (74.0)	164 (73.5)		511 (74.4)	278 (73.0)	
	Severe	128 (15.1)	38 (17.1)		102 (14.8)	64 (16.8)	
Type of HL, n (%)	Sensorineural	571 (67.6)	137 (61.4)	0.195	461 (67.2)	247 (64.8)	0.324
	Mixed and Conductive	129 (15.3)	43 (19.3)		102 (14.9)	70 (18.4)	
	‖Combined type	144 (17.1)	43 (19.3)		123 (17.9)	64 (16.8)	
HA cost per unit,‡ SGD	Median (IQR)	1749.18 (1210.75)	1471.99 (1146.46)	<0.001	1830.85 (1185.42)	1525.35 (1194.17)	<0.001
Total HA cost,‡ SGD	Median (IQR)	1950.95 (1529.01)	1620.06 (1701.16)	0.001	2133.51 (1515.64)	1616.19 (1601.09)	<0.001
Laterality, n (%)	Unilateral	707 (83.7)	169 (75.8)	0.006	565 (82.2)	311 (81.6)	0.802
	Bilateral	138 (16.3)	54 (24.2)		122 (17.8)	70 (18.4)	
Type of HA,§ n (%)	BTE HA all types	601 (71.2)	160 (73.1)	0.588	496 (72.3)	265 (70.3)	0.487
	In-Ear HA all types	243 (28.8)	59 (26.9)		190 (27.7)	112 (29.7)	
Total subjects		844 (100.0)	219 (100.0)		686 (100.0)	377 (100.0)	
	Standard BTE	574 (95.5)	150 (93.7)	0.358	473 (95.4)	251 (94.7)	0.693
	RIC BTE	27 (4.5)	10 (6.3)		23 (4.6)	14 (5.3)	
BTE HA all types		601 (100.0)	160 (100.0)		496 (100.0)	265 (100.0)	
	ITE	49 (20.2)	20 (33.9)	0.076	37 (19.5)	32 (28.6)	0.041
	ITC	99 (40.7)	19 (32.2)		71 (37.4)	47 (42.0)	
	CIC	95 (39.1)	20 (33.9)		82 (43.1)	33 (29.4)	
In-Ear HA all types		243 (100.0)	59 (100.0)		190 (100.0)	112 (100.0)	

BTE: behind the ear; CIC: completely in the canal; HA: hearing aid; HAE: hearing aid evaluation; HL: hearing loss; IQR: interquartile range; ITC: in the canal; ITE: in the ear; PHAF: post-hearing aid fitting; PTA: pure tone audiometry; SGD: Singapore dollar
RIC: receiver in canal; SD: standard deviation; SGD: Singapore dollar
† Mild (≤40dB), Moderate (>40–70dB), Severe (>70dB).
‡ Hearing aid cost, availability of data 94.5%.
§ One subject with different types of HA in the 2 ears were excluded.
‖ Subjects with different types of HL in the two ears.

Table 3. Comparison of subjects with number of hearing disabilities at HAE categorised (total n=986)

		Number of hearing disabilities				
		0–2	3–4	5–6	7–8	*P* value
Number (%)		17 (1.7)	80 (8.1)	312 (31.7)	577 (58.5)	-
Age at first HA fitting, years	Mean (SD)	65 (17)	67 (15)	71 (13)	71 (13)	0.018
Gender, n (%)	Male	8 (47.1)	42 (52.5)	151 (48.4)	305 (52.9)	0.619
	Female	9 (52.9)	38 (47.5)	161 (51.6)	272 (47.1)	
Ethnicity, n (%)	Chinese	14 (82.3)	60 (75.0)	279 (89.4)	505 (87.5)	0.035*
	Malay	0 (0.0)	7 (8.7)	11 (3.5)	26 (4.5)	
	Indian	1 (5.9)	9 (11.3)	15 (4.8)	34 (5.9)	
	Others	2 (11.8)	4 (5.0)	7 (2.3)	12 (2.1)	
PTA aided ear, dB	Median (IQR)	52.5 (22.5)	55.7 (18.1)	61.3 (18.2)	63.8 (15.6)	<0.001
PTA better ear, dB	Median (IQR)	40.0 (22.5)	48.2 (15.7)	54.4 (20.0)	58.8 (16.2)	<0.001
HL aided ear,[†] n (%)	Mild	4 (23.5)	7 (8.8)	19 (6.1)	8 (1.4)	<0.001
	Moderate	9 (53.0)	57 (71.2)	216 (69.2)	406 (70.4)	
	Severe	4(23.5)	16 (20.0)	77 (24.7)	163 (28.2)	
	Total	17 (100.0)	80 (100.0)	312 (100.0)	577 (100.0)	
HL better ear,[†] n (%)	Mild	9 (52.9)	23 (28.7)	48 (15.4)	23 (4.0)	<0.001
	Moderate	8 (47.1)	51 (63.8)	218 (69.9)	446 (77.3)	
	Severe	0 (0.0)	6 (7.5)	46 (14.7)	108 (18.7)	
Baseline type of HL, n (%)	Sensorineural	1 (5.9)	10 (12.5)	39 (12.5)	102 (17.7)	0.259*
	Mixed and Conductive	14 (82.3)	53 (66.3)	222 (71.2)	372 (64.6)	
	‖Combination type	2 (11.8)	17 (21.2)	51 (16.3)	102 (17.7)	

BTE: behind the ear; CIC: completely in the canal; HA: hearing aid; HAE: hearing aid evaluation; HL: hearing loss; IQR: interquartile range; ITC: in the canal; ITE: in the ear; PHAF: post-hearing aid fitting; PTA: pure tone audiometry; SD: standard deviation
RIC: receiver in canal; SD: standard deviation; SGD: Singapore dollar
* Using Fisher's exact test.
† Mild (≤40dB), moderate (>40–70dB), severe (>70dB).
‡ Hearing aid cost, availability of data 94.5%.
‖ Subjects with different types of HL in the two ears.

Table 3. Comparison of subjects with number of hearing disabilities at HAE categorised (total n=986) (Cont'd)

		Number of hearing disabilities				
		0–2	3–4	5–6	7–8	*P* value
Laterality, n (%)	Unilateral	16 (94.1)	62 (77.5)	241 (77.2)	494 (85.6)	0.005*
	Bilateral	1 (5.9)	18 (22.5)	71 (22.8)	83 (14.4)	
HL pattern, n (%)	Symmetrical	10 (58.8)	49 (61.2)	213 (68.3)	415 (71.9)	0.151
	Asymmetrical	7 (41.2)	31 (38.8)	99 (31.7)	162 (28.1)	
Total HA cost‡, SGD	Median (IQR)	2595.43 (1653.59)	2281.84 (2508.31)	1940.40 (1801.46)	1806.86 (1460.00)	0.029
HA cost per unit‡, SGD	Median (IQR)	2458.50 (1952.15)	2141.20 (1304.57)	1707.49 (1175.59)	1712.75 (1190.02)	0.027
Regularity of usage, n (%)	≥4 days per week	12 (80.0)	51 (77.3)	201(85.2)	407 (87.2)	0.144*
	≤3 days per week	3 (20.0)	15 (22.7)	35 (14.8)	60 (12.8)	
Daily usage, n (%)	<4 hours	8 (53.3)	28 (43.1)	87 (36.7)	128 (27.5)	0.012*
	4–7 hours	4 (26.7)	21 (32.3)	77 (32.5)	152 (32.7)	
	>7 hours	3 (20.0)	16 (24.6)	73 (30.8)	185 (39.8)	
Type of HA§, n (%)	BTE HA all types	13 (76.5)	52 (65.8)	238 (76.3)	418 (72.4)	0.268*
	In ear HA all types	4 (23.5)	27 (34.2)	74 (23.7)	159 (27.6)	
	Total subjects	17 (100.0)	79 (100.0)	312 (100.0)	577 (100.0)	
	Standard BTE	10 (76.9)	46 (88.5)	220 (92.4)	408 (97.6)	<0.001*
	RIC	3 (23.1)	6 (11.5)	18 (7.6)	10 (2.4)	
	BTE HA all types	13 (100.0)	52 (100.0)	238 (100.0)	418 (100.0)	
	ITE	1 (25.0)	4 (14.8)	13 (17.6)	37 (23.3)	0.124*
	ITC	2 (50.0)	14 (51.9)	37 (50.0)	51 (32.1)	
	CIC	1 (25.0)	9 (33.3)	24 (32.4)	71 (44.6)	
	In ear HA all types	4 (100.0)	27 (100.0)	74 (100.0)	159 (100.0)	

BTE: behind the ear; CIC: completely in the canal; HA: hearing aid; HAE: hearing aid evaluation; HL: hearing loss; IQR: interquartile range; ITC: in the canal; ITE: in the ear; PHAF: post-hearing aid fitting; PTA: pure tone audiometry; RIC: receiver in canal; SD: standard deviation; SGD: Singapore dollar

* Using Fisher's exact test.
‡ Hearing aid cost, availability of data 94.5%.
§ One subject with different types of HA in the 2 ears were excluded.

In multivariable models, after adjusting for age, sex, laterality, and aided ear PTA, having worse PTA thresholds of the better ear (AOR=1.06, 95% CI 1.04–1.08, *P*<0.001) and being ethnically Chinese compared to Malay (AOR=3.04, 95% CI 1.21–7.64, *P*=0.018) were associated with subjects reporting ≥5 compared to ≤4 disabilities at baseline (Table 4).

Reduction in hearing disability at PHAF

A reduction in ≥5 disabilities was reported by 67.5% of the subjects at PHAF. Subjects with worse better ear PTA thresholds and who used their HAs more frequently reported reduction of more disabilities.

In multivariable models, after adjusting for age, sex, ethnicity, HL symmetry, aided ear PTA, regularity of usage (self-reported), and type of HA, worse better ear PTA thresholds at baseline (AOR=1.03, 95% CI 1.01–1.05, *P*<0.001), sensorineural HL compared to combination type of HL (AOR=1.70, 95% CI 1.02–2.83, *P*=0.041), and daily HA usage for 4–7 hours (AOR=1.86, 95% CI 1.24–2.80, *P*=0.003) and >7 hours (AOR=2.30, 95% CI 1.51–3.52, *P*<0.001) compared to <4 hours were associated with subjects reporting reduction in ≥5 disabilities compared to ≤4 disabilities at PHAF (Table 5).

Subjects who reported reduction in 'difficulty with 1:1 conversation in quiet' and 'hearing loss limits social life' were more likely to use HA >7 hours daily, while those who reported reduction in 'family member feels frustrated' were more likely to use HA ≥4 days per week.

Discussion

Compared to Malay subjects, Chinese subjects were more likely to report ≥5 disabilities at HAE. This was despite Malay subjects being more likely to present with more severe HL (>55dB).[26] Perception of hearing disability is influenced by the socio-cultural norms of different ethnic groups. Within Singapore, compared to Chinese subjects, Malay subjects had lower odds of reporting poor health despite having higher comorbidities.[27, 28]

HAs were self-funded during the study period. Subjects with fewer hearing disabilities paid more for HAs, tended to be younger, more likely to be employed and have better insight into their condition, and also preferred receiver in canal type HAs, which were more expensive.[26]

At the time of the study, HHIE was yet to be validated for use in the Singapore population. Earlier attempts at using HHIE found some questions to be difficult and irrelevant within the socio-cultural context of Singapore. For example, many subjects would answer 'no' to 'do you feel handicapped by a hearing problem?' despite reporting significant difficulties elsewhere in the questionnaire as the word 'handicap' may potentially carry a negative connotation. Another question, 'does a hearing problem cause you to attend religious services less often than you would like?' may not be relevant to certain subjects. A study on 338 elderly Singapore residents (92.5% of whom were non-HA users) found poor correlation between HHIE scores and severity of HL.[29]

However, our HA user subjects showed a good linear correlation between the number of self-reported hearing disabilities at baseline and better ear PTA thresholds. The 10 HHIE questions focus mainly on emotional and social difficulties,[29] whereas our 8 questions directly assess various situational hearing disabilities.

Worse better ear PTA thresholds, sensorineural HL, and higher daily HA use were independently associated with subjects reporting more reduction in hearing disabilities. European and Australian cohorts have also reported positive correlations between hours of HA use and HA satisfaction.[21,23,30] This association is not surprising, but causality cannot be determined from our study. Causality for whether subjects used HAs more because of perceived reductions in hearing disabilities or whether increased HA use led to reduction in hearing disabilities can be further explored.

A Taiwanese study found that only 21.4% of 555 subjects with disabling HL (>40dB HL of the better ear) reported themselves as hearing handicapped, using a score of ≥10 as the cut-off on the HHIE-Screening.[31] While essential from an epidemiological viewpoint, the binary 'yes/no' classification of hearing disability has limited usefulness in managing individual patients. Patients' understanding of HL needs to move beyond the 'deaf' versus 'not deaf' dichotomy.

Focusing on patients' self-reported disability and severity will help them understand the continuum of disability. This personalised education and counselling can help patients come to terms with the negative impact HL may have on their quality of life. While hearing disability is related to the severity of HL,[32] patients' willingness to wear HAs is poorly predicted by the severity of their HL.[33] Instead, patients who were functionally independent were more accepting of HAs, as they were more likely to feel affected by their hearing disability and handicap.[33]

The results of this study can also help in managing patients' expectations about HAs. For example, for

Table 4. Unadjusted and adjusted OR and 95% CI for subjects reporting ≥5 disabilities compared to ≤4 disabilities at HAE

Variable	Unadjusted	Adjusted*	P value†
	OR (95% CI)	OR (95% CI)	
Gender			
Male	1.00	1.00	
Female	1.01 (0.66–1.53)	1.07 (0.68–1.67)	0.763
Age at first fitting (years)	1.02 (1.00–1.03)	1.00 (0.98–1.01)	0.985
Ethnic group			
Malay	1.00	1.00	
Chinese	2.00 (0.86–4.65)	3.04 (1.21–7.64)	0.018
Indian	0.92 (0.32–2.66)	1.51 (0.47–4.81)	0.479
Other	0.59 (0.17–2.03)	1.31 (0.34–5.09)	0.688
Laterality			
Unilateral	1.00	1.00	
Bilateral	1.16 (0.68–1.97)	1.22 (0.69–2.15)	0.492
Better ear PTA (dB)	1.06 (1.05–1.08)	1.06 (1.04–1.08)	<0.001
Aided ear PTA (dB)	1.03 (1.01–1.05)	1.00 (0.98–1.01)	0.876

CI: confidence intervals; HAE: hearing aid evaluation; OR: odds ratios; PTA: pure tone audiogram
* Multivariable logistic regression, adjusting for factors shown in table.
† P value shown is for adjusted odds ratios.

'difficulty hearing in noise', while 67.5% of subjects still had this disability after HA fitting, 78.2% of these subjects had reported a reduction in this disability. Hence, the focus should be on disability reduction rather than complete resolution.

Several study limitations should be considered when drawing conclusions from this study. Factors which could influence subjects' decision for HA use, such as socio-economic status, level of education, concern about cosmesis, and willingness to spend on HAs were not collected. The non-responders in our study also included subjects with dementia, who were unable to answer the questions.

Owing to the retrospective nature of the study, the possible causes of baseline disability cannot be assessed. However, reasonable conclusions can be drawn regarding reduction of disability since the determinants were collected before such reduction. We were unable to examine whether further reduction in disability occurred beyond the first few months after HA fitting as further administration of the questionnaire during subsequent visits was not part of our care protocol. A previous study found no significant changes over time[35] but the results have not been validated in a Singapore setting. A prospective study with mid- to long-term follow-up (6 months to over 2 years) would better capture the improvement in disability after HA optimisation. It would be beneficial to study the influence of different fitting formulas and amplification settings on disability reduction in a prospective study.

Despite the above limitations, the study has important strengths. After careful and meticulous extraction, only 10 (0.9%) subjects were excluded from the study due to missing data. A good response rate to the questionnaires (79% for baseline, and 64% for both baseline and follow-up) and the absence of detectable responder bias improves the generalisability of the results.

The response scale captured the level of individual hearing disability in finer granularity compared to most earlier studies, allowing a more precise understanding in disability reduction after HA fitting.

As our audiology unit sees one of the largest numbers of HL patients in Singapore, we are confident the study population was representative of the Singapore population. The findings of this study, particularly the ethnic differences in hearing disability and daily usage as a predictor of improvement in disability, have important implications for practice and policy.

Table 5. Unadjusted and adjusted OR and 95% CI for subjects reporting reduction in 5 or more disabilities compared to 4 or fewer disabilities at PHAF follow-up

Variable	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)	*P* value†
Gender			
Male	1.00	1.00	
Female	1.00 (0.73–1.35)	1.04 (0.75–1.44)	0.808
Age at first fitting (years)	1.01 (1.00–1.02)	1.00 (0.99–1.02)	0.155
Ethnic group			
Other	1.00	1.00	
Chinese	1.42 (0.53–3.79)	1.36 (0.47–3.95)	0.567
Indian	2.18 (0.62–7.64)	2.07 (0.53–8.10)	0.293
Malay	1.84 (0.56–6.06)	2.03 (0.55–7.45)	0.285
Symmetry			
Asymmetrical	1.00	1.00	
Symmetrical	1.30 (0.94–1.81)	0.79 (0.50–1.23)	0.298
Better ear PTA (dB)	1.03 (1.01–1.04)	1.03 (1.01–1.05)	<0.001
Aided ear PTA (dB)	1.01 (0.99–1.02)	0.98 (0.96–1.00)	0.085
Baseline type of HL			
Combination type‡	1	1	
Mixed and Conductive	2.03 (1.17–3.52)	1.70 (0.91–3.20)	0.095
Sensorineural	1.44 (0.97–2.12)	1.70 (1.02–2.83)	0.041
Regularity of Usage			
≤3 days per week	1	1	
≥4 days per week	1.93 (1.26–2.95)	1.30 (0.80–2.10)	0.282
Daily usage			
<4 hours	1.00	1.00	
4–7 hours	1.84 (1.26–2.68)	1.86 (1.24–2.80)	0.003
>7 hours	2.50 (1.71–3.66)	2.30 (1.51–3.52)	<0.001
Type of HA			
In ear HA	1.00	1.00	
Behind the ear HA	1.27 (0.90–1.79)	1.06 (0.72–1.55)	0.750

CI: confidence intervals; HA: hearing aid; HL: hearing loss; OR: odds ratios; PHAF: post-hearing aid fitting; PTA: pure tone audiogram

* Multivariable logistic regression, adjusting for factors shown in table.
† *P* value shown is for adjusted odds ratios.
‡ Subjects with different types of HL in the two ears.

Conclusion

In a sizeable consecutive cohort of first-time HA users in Singapore, we found baseline self-reported hearing disability to be high, with ethnicity and better ear PTA thresholds to be independently associated with disability. Higher daily HA usage, and worse better ear PTA thresholds were associated with reduction in disability after HA fitting.

Patients with worse hearing and more baseline hearing disability should be reassured that they are more likely to be wearing their HAs, and more likely to report hearing disability reduction. Conversely, patients who fail to report improvement should be counselled to use their HA more frequently.

Counselling patients on the benefits of HL rehabilitation could focus on hearing disability rather than PTA thresholds. The management of patients' expectations could focus on reducing disability rather than eliminating disability.

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