Prevalence of cognitive impairment and its association with hearing loss among adults over 50 years of age: Results from a population-based survey in Santiago, Chile.

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Abstract

Purpose: to estimate the prevalence of cognitive impairment and explore its association with hearing loss and other socio-demographic and clinical risk factors, using an objective measurement of hearing levels, in adults over 50 years of age.

Method: A population-based survey was completed in Santiago, Chile between December 2019 and March 2020. Participants were screened for cognitive impairment using the Short Chilean Minimental State Examination (SCh-MMSE) and hearing levels were assessed with tonal audiometry (HearTest). Data on demographic, socio-economic and clinical characteristics were collected.

Results: A total of 538 persons completed the assessment. The prevalence of cognitive impairment in the 50+ population was 9.3 per cent (95% CI = 5.8, 14.7). Cognitive impairment was significantly higher in individuals with any level of hearing loss (OR = 2.19 (95% CI = 1.00, 4.80) adjusted for age, sex, education, SEP and head trauma). Subjects with hearing loss and who reported any use of hearing aids (16% of the sample) had a lower risk of cognitive impairment (OR of non-users 3.64 (95% CI = 1.00, 13.28) adjusted for age, sex, education, SEP and head trauma).

Conclusions: Strategies for addressing cognitive impairment should further explore the integration of early diagnosis of hearing loss and the regular use of hearing aids.

Introduction

Globally the world's population is ageing (Mathers et al. 2015). By 2050 it is expected that 15.9 per cent of the world population will be aged 65 or greater, and, for Latin America and the Caribbean (LAC) region, these estimates are even higher at 19 per cent by 2050 (United Nations, Department of Economic and Social Affairs 2019). This demographic change has an impact on health conditions. Dementia and hearing loss are both associated with increasing age (Tarawneh and Holtzman 2012). There are more than 40 million people with dementia worldwide, and this total is expected to reach 152 million by 2050 (Organization 2017) and nearly two-thirds of all people over 70 years have hearing loss (Goman and Lin 2016) (Feder K, Michaud D, Ramage-Morin P, McNamee J 2015). Both are main causes of years lived with disability (DALYs) in older populations (Abbafati et al. 2020).

Dementia or major neurocognitive disorder is defined as an acquired cognitive impairment of sufficient severity to interfere with functioning in daily living, causing dependence (Tarawneh and Holtzman 2012). When cognitive impairment does not significantly affect functioning, is termed 'mild cognitive impairment' or minor neurocognitive disorder. The term "cognitive impairment" includes both conditions, that is major and minor neurocognitive disorders (Livingston et al. 2017). The global prevalence of mild cognitive impairment varies between 5 per cent and 41 per cent in people over 65 years of age. This observed variation in prevalence is largely related to the tests and cut-offs used for diagnosis

(Pais et al. 2020) (Creavin et al. 2016). Also varying exposure to different risk factors in different settings.

Hearing loss measured by pure-tone audiometry has a significant association with cognitive impairment, as it is possible to see in the systematic review of Loughery et al. (OR = 1.9; 95% CI 1.39, 2.89) (Loughrey et al. 2018). Further, epidemiological studies on the association between cognitive impairment and hearing loss have been conducted in Europe, United States, Japan, and Australia. Nevertheless, there is a lack of reports from Latin America. The prevalence of risk factors for cognitive impairment vary in different settings, therefore it is important to have local data on the association between hearing loss and cognitive impairment. The collection of local data is important for informing the adequate allocation of resources and provision of health services.

Another important issue to consider is that .the scarce local literature, on this association in Latin America, typically relies on self-report for the diagnosis of hearing loss, which has been shown to be an unreliable indicator of hearing impairment especially in older people (Feder K, Michaud D, Ramage-Morin P, McNamee J 2015) (Nondahl et al. 1998) (Hannula et al. 2011). Other factors found to be associated with poor agreement between self-reported and clinically assessed hearing loss include: female sex, older age, no educational qualifications, routine or manual occupation, tobacco consumption, alcohol intake, and lack of moderate physical activity (Tsimpida, D., Kontopantelis, E., Ashcroft, D., & Panagioti 2020).

Hearing loss is a sensorial deficit, which can be improved with rehabilitation and use of assistive technologies, such as hearing aids and cochlear implants (Thomson et al. 2017). Some studies have found that the increased incidence of cognitive decline in older adults is restricted to persons with hearing loss that do not use amplification (Ray, Popli, and Fell 2018). Cohort studies have shown that use of hearing aids could reduce the incidence of dementia (Maharani et al. 2018) (Mahmoudi et al. 2019), however, at the moment there are no clinical trials that confirm this association.

The objectives of this paper are to estimate the prevalence of cognitive impairment and explore its association with objectively measured hearing loss, and use of hearing aids among adults 50 years of age and older in Santiago, Chile.

Method

A Rapid Assessment of Hearing Loss (RAHL) survey (Bright et al. 2019), was completed in the province of Santiago, Chile between December 2019 and March 2020. This is a population based survey methodology which aims to estimate the prevalence and probable causes of hearing loss among people aged 50 and over in a relatively rapid and affordable manner (Bright et al. 2019). A cognitive impairment screen was also included in the current study.

Sample size and sampling

The RAHL sample size and sampling methodology has been published in detail elsewhere (Bright et al. 2019). In summary, a two-stage cluster sampling procedure was used to identify approximately 1200 participants aged 50 years and above. First, 40 clusters (Manzanas or blocks) were selected from the most recent census (2017) using probability-proportionate-to-size sampling. Next, households within clusters were selected using compact segment sampling, whereby a block was divided into segments, each containing approximately 30 people aged 50+. Segments were numbered and one segment was drawn at random using a random number generator. This segmentation used google satellite maps of the cluster provided by the population-housing census. Data were collected as part of a wider survey of hearing loss (Tamblay N, Torrente MC, Huidobro B, Tapia-Mora D, Anabalon K, Polack S 2022) which was powered to detect an expected prevalence for moderate or greater hearing loss of 11 per cent, 95% confidence, design effect of 1.4, margin of error of 20 per cent (around the estimate), and response rate of 90 per cent, This was also sufficiently powered to estimate prevalence of cognitive impairment based on an expected prevalence of 13.6 per cent (Gondim et al. 2017).

Data collection protocol

Two teams were trained for five days on study procedures, clinical testing and ethical considerations. Each team consisted of three people:

- Two audiologists to administer a sociodemographic questionnaire perform hearing assessment and perform the Short Chile Minimental State Examination (SCh-MMSE).

- One Ear Nose and Throat (ENT) resident or consultant to complete a questionnaire about the medical history of the participants, perform otoscopy and refer the participants to corresponding health facilities if necessary.

In total, four audiologists were trained to conduct the SCh-MMSE by a psychologist specialized in cognition.

A mobile-based data collection form was used to collect the data, using the Open Data Kit (ODK) platform.

Cognitive screening evaluation

The MMSE is a brief neurophysiological test developed by Marshall Folstein in 1975 (Folstein, Folstein, and McHugh 1975). It has been validated in Chile (Quiroga L., Albala B., and Klaasen P. 2004), and a short version was developed in Chile to overcome the difficulties of administering the test to participants who were illiterate (Icaza M n.d.). When developing the SCh-MMSE, Icaza and Albala selected six items from the complete version (eleven items) that explained 92% of the variance. It consists of a series of questions that evaluate the following cognitive skills: spatial and temporal orientation (day, month, year), short- and long-term memory (3 words retention), attention (inverse repetition of 5 numbers), executive capacity (verbal order with 3 steps), and visual constructive capacities (copy of two circles). Each of these questions has a maximum score of 19 points, and a score less than 13 is considered as “suspected cognitive impairment”. The SCh-MMSE had a sensitivity and

specificity of 92% when compared with the MMSE (Icaza M n.d.), and it is used in health evaluations of older adults conducted in primary health throughout Chile.

Hearing evaluation

Following the RAHL methodology (Bright et al. 2019), we measured hearing for all subjects with a validated mobile-based automated audiometry system (HearTest™, HearX Group, South Africa), paired with calibrated circumaural attenuating headphones (Sennheiser HD280™). Thresholds were obtained at 500, 1000, 2000, 4000Hz in each ear, and a pure tone average (PTA) was calculated. Ambient noise was monitored, through the HearTest app's built-in noise monitoring capability (27-44 dBA). Prior to fieldwork, the equipment was calibrated to ISO audiological standards (ISO 8253-1). Hearing loss was defined according to WHO with a PTA over 25 dB in the better ear, and severity was classified as mild (PTA between 26 and 40 dB), or moderate/worse (PTA >= 41 dB). Unilateral hearing loss was considered when hearing was normal in one ear and impaired in the other. Following audiometry and the SCh-MMSE, all participants had their ears examined with otoscopy performed by an ENT resident or consultant. Participants were also asked if they had one or more hearing aids and, if yes, about frequency of their use through the question: In the past month, how often have you worn your hearing aid(s)?, the possible response options were: Most of the day (8-16 hours), Half of the day (4-8 hours), Less than half the day (1-4 hours), Less than one hour per day (<1 hours) and None.

We also asked about self-reported hearing loss using the relevant question from the Washington Group set of questions; these are widely endorsed tools for the collection of disability statistics in surveys and censuses (Madans, Loeb, and Altman 2011). This question asks, "Do you have difficulty hearing, even if using a hearing aid?". Response options include "No, no difficulty", "Yes, some difficulty", "Yes, a lot of difficulty", or "Cannot do at all" (Madans, Loeb, and Altman 2011).

Evaluation of other risk factors of cognitive impairment

We collected data on the following seven socio-demographic and health-related variables: education, socio-economic position, traumatic brain injury, blood pressure, smoking and diabetes (see Figure 1).

Figure 1: Question and answer choices about risk factors of cognitive impairment

Ethical Consideration

Ethical approval was obtained from London School of Hygiene & Tropical Medicine Research Ethics Committee (United Kingdom), and the Ethics Committee for Research in Human of the Faculty of Medicine from the Universidad de Chile. All participants provided written informed consent. For those with profound hearing loss, or those with communication difficulties, a family member assisted the process of information and consent. Participants identified as having hearing loss or cognitive impairment were referred as appropriate.

Data entry and analysis

Stata version 16.0 (StataCorp LP, College Station, Texas) was used to manage and analyze the data. The cluster design was accounted for in the analysis using the "svy" command. The age and sex distribution of the study sample was compared to the 2017 Chile Population Housing Census data to assess how representative the study sample was in terms of age and sex. To account for the observed differences in age and sex distribution in comparison to the general population, our analyses were weighted to minimize the effect of this potential bias (Chilean National Institute of Statistics 2020). Outcomes included the prevalence of cognitive impairment (less than 13 points in the SCh-MMSE), hearing loss (none <25dB pure tone average, mild >=25dB to 40 dB oure tone average, moderate or worse >=41dB pure tone average and any ≥=25dB pure tone average). Although the study included adults aged 50+ years, we also present cognitive impairment prevalence estimates for 60+ years to allow comparison to other studies restricted this age group.

A Socio-Economic Position (SEP) index was created through a principal component analysis of household ownership of assets and this was divided into quintiles

Logistic regression analysis was used to assess the association between cognitive impairment with 1) level of hearing loss, 2) self-reported hearing difficulties and 3) hearing aid use. Model 1 was unadjusted, Model 2 controlled for age (as a continuous variable) and sex, and Model 3 was additionally adjusted for socio-economic variables (level of education and SEP)

and head trauma as potential confounders. In addition, logistic regression analysis assessed the association between cognitive impairment with socio-economic and health related risk factors (education, SEP, head trauma, diabetes, and high blood pressure). A SEP index was created through a principal component analysis of household ownership of assets and this was divided into quintiles.

Results

A total of 1135 participants aged 50+ were enumerated, and 538 completed the survey (47.4 per cent response rate), 64.6 per cent of them were female. The population included in the study slightly under-sampled the younger population groups (50-59 years), and over sampled the older age groups (70-79 years and 80+ years) and females, according to the most recent country census. Given the differences between the census and the sample, our analyses were weighted to account for the differences in age and sex in comparison to the general population (Tamblay N, Torrente MC, Huidobro B, Tapia-Mora D, Anabalon K, Polack S 2022). In total, 534 participants are included in this cognition sub-study due to four participants having missing data on cognitive impairment.

Prevalence of cognitive impairment

The prevalence of cognitive impairment in the 50+ population was 9.3 per cent (95% CI = 5.8, 14.7). It was significantly higher in females and increased with age, almost tripling in subjects over 70 years compared to 50-60 years (Table 1). The prevalence of cognitive impairment in the 60+ population of Santiago was 13.6% (95% CI = 8.1, 22.1).

Association between cognitive impairment and hearing loss.

The prevalence of any hearing loss in the population aged 50+ was 41.0 per cent (95% CI= 33.2, 49.2) and increased with age to 76.8% (95% CI= 56.6, 89.4) among individuals aged 80 years of age or older.

The prevalence of cognitive impairment in people with any hearing loss was 16.4%, and 22.3% in the group with hearing loss moderate or greater (Table 1).

Table 1: Prevalence of cognitive impairment by gender and age and level of hearing loss (weighted for population of Santiago, Chile) (n=534*)

Cognitive impairment and socio-demographic and health conditions

The following socio-demographic and health condition variables were significantly associated with having cognitive impairment: *increasing* age (OR: 1.09; 95% CI 1.04, 1,13), being female (OR: 2.33; IC 1.15, 4.73), lower socioeconomic position (SEP) (OR = 6.26; 95%

CI = 1.96, 20.0), lower level of education (OR = 2.99; 95% CI = 1.46, 6.13) and history of head trauma (OR = 3.48; 95% CI = 1.59, 7.61) (see Table 2).

Table 2: Association between cognitive impairment and socio-demographic and health conditions (n=534)

Association adjusted between cognitive impairment and hearing loss

The three models used considering cofounding factors in the association between cognitive impairment and hearing loss (Table 3). We found that people with mild (OR=2.44, 95% CI 1.16-5.13, p=0.02) and moderate (OR=3.22, 95% CI 1.37-7.57, p=0.009) hearing loss were significantly more likely to have cognitive impairment compared to people with no hearing loss, with adjustment for age and sex (logistic regression model 2) (table 3). However, these associations were no longer statistically significant with additional adjustment for education, SEP and head trauma (logistic regression model 3).

Any level of hearing loss was significantly associated with cognitive impairment (OR 2.68, 95% CI 1.38-5.19) when adjusted by age and sex (logistic regression model 2). When additionally adjusted for cofounding factors of age, sex, education, SEP and head trauma, this association weakens and was of borderline significance (OR 2.19, 95% CI 1.00- 4.80) (logistic regression model 3) (Table 3).

In contrast, there was no association between self-reported hearing loss and cognitive impairment.

Impact of use of hearing aids on cognitive impairment.

Overall, among people with any level of hearing loss, 16 per cent owned a hearing aid, but only an 8.6 per cent reported using it for more than half day. Any use of a hearing aid was significantly associated with cognitive impairment, with adjustment for age and sex (logistic regression model 2) and additional socio-economic variables and head trauma (logistic regression model 3) (OR = 3,64; CI 95% 1.00 – 13,28). The risk of having cognitive impairment was four times higher among people with hearing loss who did not wear a hearing aid compared to those who used a hearing aid more than or equal to half a day per day (OR = 4.30; CI 1.11-16.61).

Table 3: Association between any cognitive impairment, hearing loss, and hearing aid use (n=534)

Discussion

In this study we estimated the prevalence of cognitive impairment and explored the relationship between cognitive impairment and hearing loss, measured using a cognitive screen test and audiometric hearing thresholds respectively, among adults aged 50+ in Santiago Chile.

The estimated prevalence of cognitive impairment was 9.3 per cent (95% CI = 5.8, 14.7) among adults aged 50+ and 13.6 per cent (95% CI = 8.1, 22.1) among adults aged 60+. In accordance with previous literature, the prevalence increased significantly with age, to 36.7 per cent (95% CI 20.9, 56.1) among participants aged over 80 years. Comparing to previous data from Chile, our findings are similar to the 12.2 per cent reported in 2017 in people over 60 years, using MMSE in the national health survey (Salud 2017). In comparison to global estimates, the overall prevalence was greater than the 7.4% (95% CI 5.5%, 20.1%) reported in the meta-analysis with 34 studies by Creavin et al in world population over 65 years, but is similar to that reported in that study after adjusting for education (13.8 per cent (95% CI 2.4%, 27.4%)) (Creavin et al. 2016). Comparing studies using MMSE to assess cognitive impairment in population 60+ from other countries in Latin America, our prevalence of cognitive impairment was similar to those found in in Fortaleza city, Brazil, of 13.6 per cent (95% CI 10.33, 16.64) (Gondim et al. 2017), and lower compared to estimates from Argentina 23.2 per cent (Arizaga et al. 2014) which can be explained because the average age of the study in Argentina was 70.9, while the average age in this study is 66.8 years.

Hearing loss as risk factor for cognitive impairment

In our sample, hearing loss (>25 dB in the better ear) was associated with cognitive impairment, even after multivariate adjustment. In terms of level of severity, people with mild and moderate hearing loss were more likely to have cognitive impairment compared to those without hearing loss, when adjusted by age and sex. However, this association was

weakened and no longer significant with adjustment for additional factors (education, SEP, and head trauma), indicating confounding in this relationship. Some caution is warrented in this interpretation, however, due to the relatively small simple size, it is possible the association between hearing loss and cognitive impairment, might have remained significant even in subgroups according to hearing loss severity. Also, this observation highlights the influence of socioeconomic factors on the association between hearing loss and cognitive impairment. Previous reports include population from developed countries with higher education and access to health.

The mechanistic pathways hypothesized to explain this observed association between hearing loss and cognitive impairment include a shared pathologic etiology, the effects of hearing loss on cognitive load (the amount of working memory resources used for hearing) and cognitive reserve (the amount of working memory resources used for hearing), and/or mediation through social isolation and loneliness (Lin et al. 2013).

In our population, among people with hearing loss, those using hearing aids is were less likely to have cognitive impairment. Other reports have described previously this relationship (Amieva et al. 2015) (Glick and Sharma 2020). The risk of having cognitive impairment was four times higher among people with hearing loss who did not wear a hearing aid compared to those who used a hearing aid for more than or equal to half a day per day. Nevertheless, this data should be considered carefully considering the relatively small numbers included in the analysis. Among the 253 participants with any level of bilateral hearing loss bilateral, a 16% had hearing aids, and only 8.6% used the device for more than half a day. Randomized

control studies or large cohort studies are needed to adequately assess the protective role of hearing aids.

In Chile, all people older than 65 years of age, regardless of socio-economic status, with moderate or worse bilateral hearing loss have access to hearing aids provided by the health insurance (private or government). We did not find a significant association between self-reported hearing loss and cognitive impairment. Other studies have suggested a poor correlation between self-reported difficulties with hearing and clinically assessed hearing loss (Feder K, Michaud D, Ramage-Morin P, McNamee J 2015) (Valete-Rosalino and Rozenfeld 2005). It is also possible that people with hearing loss may be less likely to report hearing difficulties because they consider this to be part of the ageing process, particularly with a mild or moderate impairment (Nondahl et al. 1998) (Wiley et al. 2000).

Our finding highlights the value of using tonal pure audiometry rather than self-reported hearing difficulties in studies exploring hearing loss as a risk factor for cognitive impairment.

Study strengths and limitations

The strengths of this study included the objective assessment of auditory thresholds and the use of a validated standardized tool for assessing cognitive impairment. Many previous studies of the association between cognition and hearing loss relied on self-report of auditory status (Marrone et al. 2019), a variable that may not correlate with hearing thresholds according to our results. To the best of our knowledge, this is the first study from Latin America assessing the relationship between an objective clinical measurement of hearing loss and cognitive

impairment. However, this study has limitations. The instrument we used for the assessment of cognitive impairment has been found to have good sensitivity when compared with the complete MMSE (Jiménez et al. 2017). Nevertheless, it has the advantage that was designed to be used with people with lower levels of education/literacy, and it is an instrument widely used in Chile. Evidence suggests the MMSE has a low sensitivity for detecting mild cases of dementia but is very adept at differentiating more serve cases of dementia (Kalish V 2016). Further, the overall survey had a low response rate of 47.4 per cent, with a refusal rate of 16.1 per cent, and unavailable rate of 36 per cent. The smaller sample size may lead to biased reducing the precision of the estimates, and this issue was addressed by reporting the 95% confidence intervals, that are noted to be wide. Though efforts were made to minimize the effect of this potential bias on the results by weighting the results according to age and sex distribution of the census, this should be noted when interpreting the results.

Since this study is a cross-sectional study, the presence of reverse causality is possible, for example cognitive impairment could prevent patients from using hearing aids because they forgot or loose the device, and this in turn explain an increased risk.

To further explore this issue there is a need of longitudinal studies.

Conclusions

The estimated prevalence of cognitive impairment in adults over 60 years of age was 13.6 per cent (95% CI = 5.8, 14.7). Hearing loss was associated with cognitive impairment after adjustment for cofounders. Use of hearing aids in persons with hearing loss could be a

protective factor for cognitive impairment, but the design of our study limits our conclusions on this issue.

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Data is available upon request from the corresponding author.

Data Availability Statement

Data not available due to ethical restrictions

Disclosure statement

The authors report no conflict of interest.

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Table 1: Prevalence of cognitive impairment by gender and age and level of hearing loss (weighted for population of Santiago, Chile) (n=534*)

	Total	**Number with cognitive impairment****	**Prevalence of cognitive impairment**
	N (%)	N	% (95% CI)
TOTAL	534	70	9.3 (5.8-14.7)
Gender			
Male	189 (35.4%)	20	5.6 (2.5-12.1)
Female	345 (64.6%)	50	12.2 (7.8-18.4)
Age groups			
50-59	174 (32.6%)	10	4.9 (2.2-10.4)
60-69	144 (27.0%)	10	5.9 (2.8-11.8)
70-79	139 (26.0%)	21	15 .0(8.9-24.2)
80+	77 (14.4%)	29	36.7 (20.9-56.1)
Hearing loss			
None	267 (50.0%)	15	4.5 (2.4-8.3)

Mild (>25dB to <41dB better ear)	148 (27.7%)	22	13.2 (7.8-21.7)
Moderate or greater (>40dB better ear)	119 (22.3%)	33	22.3 (11.2-39.5)
Any level (>25dB ear better ear)	267 (50.0%)	55	16.4 (10.0-25.7)

**Total of 534 survey participants due to 4 survey participants missing SCh-MMSE data; Total overall hearing survey participants n=538; ** Participants who scored <13 using the SCh-MMSE screen;*

Table 2: Association between cognitive impairment and socio-demographic and health conditions (n=534)

	Total	**People without cognitive impairment**	**People with cognitive impairment**	**Logistic regression**	
	N (%)	N (%)	N (%)	Adjusted OR^ (95%CI)	P value
TOTAL	534 (100)	464 (86.9)	70 (13.1)	--	--
Age (continuous)				1.09 (1.04-1.13)	**<0.001**
Sex					
Male	189 (35.4)	169 (36.4)	20 (28.6)	Base	--
Female	345 (64.6)	295 (63.6)	50 (71.4)	2.01 (1.02-3.93)	**0.043**
SEP quartile^^					
4 - richest	204 (38.7)	189 (41.36)	15 (21.4)	Base	--
3	93 (17.7)	86 (18.8)	7 (10.0)	0.91 (0.26-3.2)	0.886
2	193 (36.6)	154 (33.7)	39 (55.7)	1.98 (0.84-4.66)	0.114
1 - poorest	37 (7.02)	28 (6.1)	9 (12.9)	6.26 (1.96-20)	**0.003**
Education					
Primary or	438 (82)	396 (85.3)	42 (60.0)	Base	--

greater					
Never attended	96 (18)	68 (14.7)	28 (40.0)	2.99 (1.46-6.13)	**0.004**
Non-communicable diseases					
Hypertension[&]	270 (50.8)	225 (48.7)	45 (64.3)	1.54 (0.76-3.13)	0.223
Diabetes[&]	131 (24.6)	112 (24.2)	19 (27.1)	1.27 (0.66-2.43)	0.458
Smoking[&] **	339 (63.7)	300 (64.9)	39 (55.7)	0.98 (0.49-1.97)	0.955
Head Trauma[&]	68 (12.8)	54 (11.7)	14 (20.0)	3.48 (1.59-7.61)	**0.003**

*^ adjusted for age and sex; **current or previous; & 2 missing values due to missing questionnaires; ^^10 missing values due to missing questionnaires, and choice of "prefer not to say"*

Table 3: Association between any cognitive impairment, hearing loss, and hearing aid use (n=534)

	Total	**People without cognitive difficulties**	**People with cognitive difficulties**						
	N (%)	N (%)	N (%)	Unadjusted OR1 (95%CI)	P value	Adjusted OR2^ (95%CI)	P value	Adjusted OR2^ (95%CI)	P value
Level of hearing loss (by severity)									
None (≤ 25dB)	267 (50.0)	252 (54.3)	15 (21.43)	Base	--	Base		Base	
Mild (26-40dB)	148 (27.7)	126 (27.2)	22 (31.43)	3.25 (1.49-7.09)	**0.004**	2.44 (1.16-5.13)	**0.020**	2.15 (0.91-5.10)	**0.079**
Moderate or greater (> 40 dB better ear)	119 (22.3)	86 (18.5)	33 (47.1)	6.12 (2.54-14.75)	**<0.001**	3.22 (1.37-7.57)	**0.009**	2.26 (0.85-6.00)	0.1
Any level hearing loss (>25dB ear better ear)	267 (50)	212 (45.7)	55 (78.6)	4.18 (2.03-8.58)	**<0.001**	2.68 (1.38-5.19)	**0.005**	2.19 (1.00-4.80)	**0.051**
Self-reported HL*									
None	295 (55.5)	251 (54.3)	44 (62.9)	Base	--	Base		Base	
Mild+ (Some difficulty+)	237 (44.6)	211 (45.7)	26 (37.1)	0.93 (0.48-1.79)	0.827	0.70 (0.30-1.65)	0.405	0.64 (0.26-1.56)	0.318
Moderate+ (A lot/severe+)	43 (8.1)	36 (7.8)	7 (10.0)	1.44 (0.60-3.46)	0.399	0.95 (0.43-2.08)	0.343	0.58 (0.29-1.19)	0.136
Hearing aid use (any) among people with any HL (n=267)**									

Hearing aid use (any)	43 (16.1)	38 (17.9)	5 (9.1)	Base	--	Base		Base	
No hearing aid use	224 (83.9)	174 (82.1)	50 (90.9)	1.41 (0.37-5.36)	0.605	3.24 (0.80-13.09)	0.096	3.64 (1.00-13.28)	0.051
Hearing aid use (≥half day)	23 (8.6)	20 (9.4)	3 (5.5)	Base	--	Base		Base	
No hearing aid use	244 (91.4)	192 (90.6)	52 (94.6)	1.63 (0.40-6.71)	0.490	3.75 (0.86-16.35)	0.077	4.30 (1.11-16.61)	

Abbreviations: HL=hearing loss. *^OR2 Adjusted for age and sex; ^^OR3 Adjusted for age, sex, education, SEP and head trauma *2 missing values due to missing questionnaires; **3 missing values due to missing questionnaires.*

Figure 1: Question and answer choices about risk factors of cognitive impairment