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The Relationship Between Hearing Loss and Chronic Health Conditions: What's the Evidence?

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Disclosures

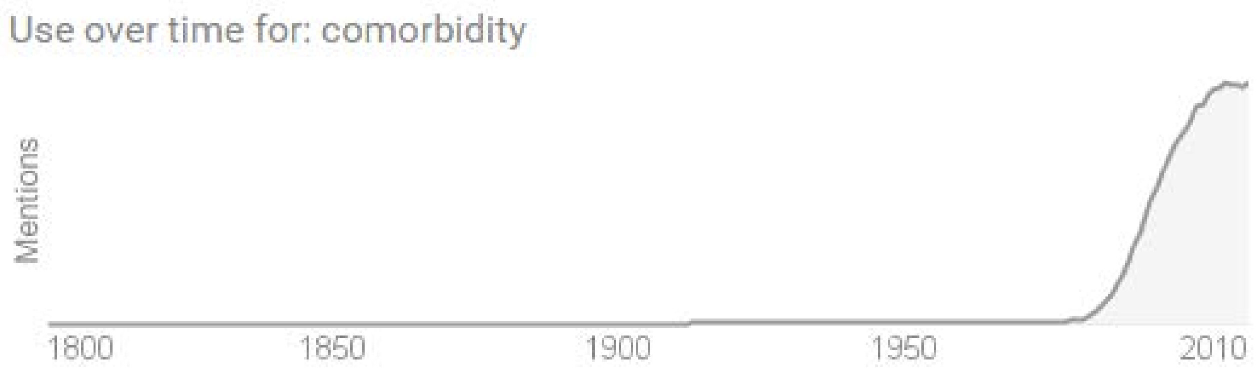
- Financial
  - Hearing Industries Association/Better Hearing Institute
  - Starkey Hearing Technologies
  - Creare, Inc.
- Nonfinancial
  - No nonfinancial relationships related to the content of this presentation

Learning Objectives

- At the conclusion of this presentation, participants will be able to:
  - List 4 comorbidities associated with hearing loss;
  - Summarize the results of 2 studies supporting the association between hearing loss and dementia;
  - Discuss the clinical implications of the studies reviewed in the presentation

Comorbidity

- The simultaneous presence of two chronic diseases or conditions in a patient
  - https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=comorbidity&*



Chronic Condition

- A human health condition or disease that is persistent or otherwise long-lasting in its effects or a disease that comes with time
- The term *chronic* is often applied when the course of the disease lasts for more than three months

https://en.wikipedia.org/wiki/Chronic_condition

Hearing Loss as a Chronic Condition

- For example, what do hearing loss and diabetes share in common?
  – Invisible
  – Progressive
  – Painless
  – Often incurable
  – Treatable
  – Professional expertise is ‘front-loaded’
  – Self-managed behavioral change is required for long-term success
  – When collaboratively self-managed, patient experiences reduced activity limitations and participation restrictions and increased QoL

Comorbid Conditions Associated with Hearing Loss

- Social Isolation
- Loneliness
- Depression
- Falls
- Cardiovascular disease
- Diabetes
- Dementia
- Mortality

Other Associations

- Fibromyalgia
- Anemia
- Psoriasis
- Rheumatoid arthritis
- Kidney disease
- Sleep apnea
- Diet

Age-Related Hearing Loss (Presbycusis)

- Sensory
- Neural
- Strial/metabolic
- Cochlear conductive
- Mixed

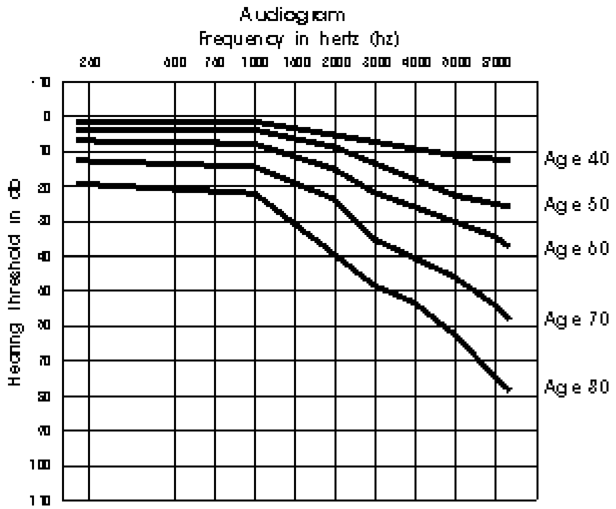


Table. Prevalence and Number of Individuals in the United States With Hearing Loss[a]

Variable	% (95% CI)[b] Prevalence of Hearing Loss ≥25 dB (Bilateral)[c] Sex: Female	Male	Race/Ethnicity[d]: White	Black	Hispanic	Total: Overall Prevalence	No. With Hearing Loss (in Millions)	Prevalence of Hearing Loss ≥25 dB (Bilateral and Unilateral)[c] Total: Overall Prevalence	No. With Hearing Loss (in Millions)
Age, y									
12-19	0.42 (0-0.91)	0.20 (0-0.41)	0.26 (0-0.66)	0.48 (0.11-0.85)	0.43 (0.04-0.82)	0.31 (0.04-0.57)	0.10	2.3 (1.5-3.1)	0.76
20-29	0.35 (0-0.79)	0.48 (0-1.4)	0.43 (0-1.3)	0.63 (0-1.9)	0.35 (0-0.90)	0.42 (0-0.97)	0.16	3.2 (1.4-5.1)	1.2
30-39	0.79 (0-1.8)	2.5 (0.14-4.9)	1.8 (0-3.8)	1.7 (0-3.9)	1.6 (0.22-3.1)	1.6 (0.23-3.1)	0.68	5.4 (3.3-7.6)	2.3
40-49	4.5 (0.94-8.1)	8.7 (5.0-12.4)	7.4 (4.5-10.3)	1.3 (0-3.3)	7.3 (2.0-12.5)	6.5 (4.1-8.8)	2.8	12.9 (9.8-15.9)	5.6
50-59	6.1 (3.6-8.6)	20.3 (14.5-26.2)	14.5 (9.9-19.2)	7.1 (3.0-11.2)	13.8 (6.4-21.2)	13.1 (9.4-16.8)	4.4	28.5 (23.3-33.7)	9.6
60-69	16.8 (12.1-21.5)	39.2 (31.7-46.8)	26.6 (21.1-32.1)	15.9 (9.8-22.1)	28.9 (17.0-40.8)	26.8 (22.3-31.4)	5.7	44.9 (40.9-48.9)	9.5
70-79	48.5 (38.5-58.5)	63.4 (56.2-70.5)	55.8 (47.6-63.9)	39.0 (26.2-51.7)	66.8 (52.3-81.2)	55.1 (48.0-62.2)	8.8	68.1 (61.2-75.1)	10.8
≥80	75.6 (69.7-81.5)	84.6 (79.0-90.3)	81.5 (78.5-84.5)	54.8 (40.6-69.0)	60.7 (34.8-86.6)	79.1 (76.0-82.2)	7.3	89.1 (86.1-92.0)	8.3
Estimated total No. of individuals with hearing loss, (in millions)						30.0[e]		48.1	

Lin et al. Arch Intern Med. 2011;171(20):1851-1853. doi:10.1001/archinternmed.2011.506

[a] National Health and Nutritional Examination Surveys 2001 through 2008 (n=7490)
[b] All values represent prevalence percentage except for the column titled "No. With Hearing Loss (in Millions)," which represents the number of prevalent cases.
[c] Hearing defined by the average of hearing thresholds at 0.5-, 1-, 2-, and 4-kHz tones presented by air conduction.
[d] Prevalence estimates by race/ethnicity are only presented for the 3 largest racial/ethnic groups. Individuals from all racial/ethnic groups are included in the overall prevalence.
[e] Numbers do not sum to group total because of rounding.

Auditory & Perceptual Consequences

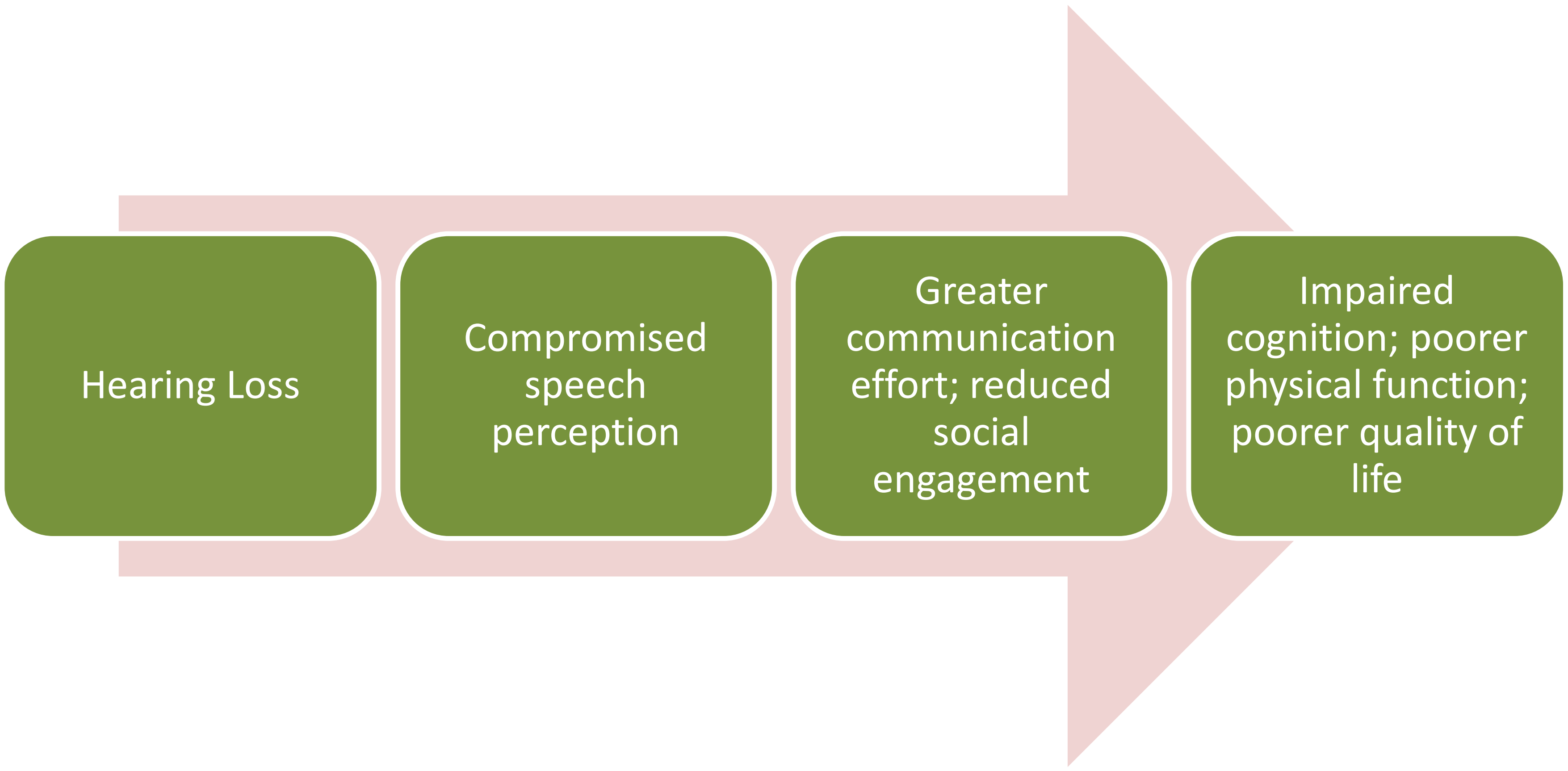
- Decreased audibility
  - Difficulty hearing low level speech & environmental sounds
- Widened auditory filters
  - Difficulty understanding speech, particularly in noise
- Reduced dynamic range
  - Increased sensitivity to high-level sounds

Consequences of Aging on Speech Perception

- Audibility
- Intelligibility
- Stream segregation (attention)
- Speed of processing
- Temporal processing (e.g. gap detection, voice-onset time)
- Working memory

Psychosocial Consequences of Compromised Speech Perception

- Withdrawal
- Reduced QoL
- Depression
- Isolation
- Cognitive decline
- Dementia(?)


Hearing Loss
Compromised speech perception
Greater communication effort; reduced social engagement
Impaired cognition; poorer physical function; poorer quality of life

Some Definitions

- **Odds ratio** = the odds that an outcome (e.g. falling) will occur given a particular exposure (e.g. hearing loss), compared to the odds of the outcome occurring in the absence of that exposure
  - Example: *The odds of falling is twice as likely among people with hearing loss than people without hearing loss*
- **Risk ratio** (relative risk) = cumulative risk of an outcome occurring over a time span
  - Example: *At the end of the study, the risk of having dementia without hearing aids is twice that with hearing aids*
- **Hazard ratio** = risk at a particular time
  - Example: *The risk of having hearing loss with CVD is twice that compared to without CVD at 5 years post-diagnosis*

SOCIAL ISOLATION & LONELINESS

TABLE 3. Multivariate analyses of associations between hearing loss and cognition, social isolation, falls, hospitalizations, depression, and burden of physical and mental health

NHANES Cycle(s)	Outcome	n	Parameter Estimate*† (95% CI)	*p*
1999–2002	Digit Symbol Substitution Test score	516	−2.14 (−4.11, −0.18)	0.03
1999–2004	Social isolation‡ (ages 60–69 years)	839	1.52 (1.19, 1.93)	0.001
2004–2005	Social isolation (ages 70+ years)	465	1.08 (0.77, 1.52)	0.61
2001–2004	Any difficulty with falling in past year	1845	1.15 (0.92, 1.43)	0.21
2005–2006 and 2009–2010	Any hospitalization in past year	1064	1.15 (0.96,1.38)	0.13
	>10 days of poor physical health in past month	1004	1.22 (0.96,1.56)	0.10
	>10 days of poor mental health in past month	974	1.21 (0.92, 1.60)	0.17
	Moderate-severe depression (PHQ-9 score ≥ 10)	974	1.09 (0.84, 1.40)	0.51

The sample includes participants with normal hearing, unacknowledged hearing loss, or unaddressed hearing loss.

**OR per 10-dB increase in PTA in the better hearing ear were estimated for each outcome except the DSST, for which a β coefficient measuring average change in DSST per 10-dB increase in PTA was estimated.*

†All analyses were adjusted for age, sex, race/ethnicity, level of education, annual household income, and histories of diabetes, congestive heart disease, coronary artery disease, myocardial infarction, angina, stroke, smoking, and hypertension.

‡Social isolation defined by having at least two of the following: no close friends, no spouse or romantic partner, no one to provide emotional support, and no one to provide financial support.

CI, confidence interval; DSST, Digit Symbol Substitution Test; NHANES, National Health and Nutrition Examination Survey; OR, odds ratios; PHQ-9, 9-item Patient Health Questionnaire; PTA, pure-tone average.

Mick & Pichora-Fuller, 2016

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Association of Hearing Loss and Loneliness in Older Adults

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Abstract

Objective: The objective of this study is to determine factors associated with loneliness in older adults presenting for hearing loss treatment. **Method:** A cross-sectional analysis was conducted of 145 participants (aged 50-94) who presented for hearing aids or cochlear implants and were enrolled in the Studying Multiple Outcomes After Aural Rehabilitative Treatment (SMART) study from 2011 to 2013. Social, communicative, physical, and mental health functioning were assessed using self-administered questionnaires, and loneliness using the University of California, Los Angeles (UCLA) Loneliness Scale. **Results:** Younger age and greater hearing loss were significantly associated with greater loneliness. Metrics of depressive symptoms and hearing-related quality of life, communication difficulties, and emotional well-being, mental health, and 36-Item Medical Outcomes Study Short-Form (SF-36) scores were moderately or highly correlated with loneliness. **Discussion:** Younger age and greater hearing loss are independently associated with higher levels of loneliness in older adults presenting to clinic for hearing loss treatment. Further studies needed to determine whether hearing treatment can reduce loneliness in older adults.

Keywords

hearing, loneliness, quality of life, aging, well-being

Change in Psychosocial Health Status Over 5 Years in Relation to Adults' Hearing Ability in Noise

Mariska Stam,[1] Jan H. Smit,[2] Jos W. R. Twisk,[3] Ulrike Lemke,[4] Cas Smits,[1]
Joost M. Festen,[1] and Sophia E. Kramer[1]

Objectives: The aim of this study was to establish the longitudinal relationship between hearing ability in noise and psychosocial health outcomes (i.e., loneliness, anxiety, depression, distress, and somatization) in adults aged 18 to 70 years. An additional objective was to determine whether a change in hearing ability in noise over a period of 5 years was associated with a change in psychosocial functioning. Subgroup effects for a range of factors were investigated.

Design: Longitudinal data of the web-based Netherlands Longitudinal Study on Hearing (NL-SH) (N = 508) were analyzed. The ability to recognize speech in noise (i.e., the speech-reception-threshold [SRTn]) was measured with an online digit triplet test at baseline and at 5-year follow-up. Psychosocial health status was assessed by online questionnaires. Multiple linear regression analyses and longitudinal statistical analyses (i.e., generalized estimating equations) were performed.

Results: Poorer SRTn was associated longitudinally with more feelings of emotional and social loneliness. For participants with a high educational level, the longitudinal association between SRTn and social loneliness was significant. Changes in hearing ability and loneliness appeared significantly associated only for specific subgroups: those with stable pattern of hearing aid nonuse (increased emotional and social loneliness), who entered matrimony (increased social loneliness), and low educational level (less emotional loneliness). No significant longitudinal associations were found between hearing ability and anxiety, depression, distress, or somatization.

Conclusions: Hearing ability in noise was longitudinally associated with loneliness. Decline in hearing ability in noise was related to increase in loneliness for specific subgroups of participants. One of these subgroups included participants whose hearing deteriorated over 5 years, but who continued to report nonuse of hearing aids. This is an important and alarming finding that needs further investigation.

Key words: Adults, Digit triplet test, Hearing status, Loneliness, Prospective study, Psychosocial functioning.

(Ear & Hearing 2016;37;680–689)

is still subject to debate. Only a small number of prospective studies investigating the relationship between hearing status and various parameters of psychosocial health have been conducted and the outcomes of these studies are not always in agreement (Table 1). In some of these studies, a moderate to severe self-reported hearing impairment at baseline appeared to be associated with higher levels of depression 1 year later (Wallhagen et al. 1996; Strawbridge et al. 2000), 3 years later (Saito et al. 2010), or even over 16 years later (Kiely et al. 2013). However, other studies failed to find such an association (Chou 2008; Pronk et al. 2011). Evidence supporting a relationship between the existence of hearing impairment at some moment in time and feelings of loneliness some years later was found more consistently (Strawbridge et al. 2000; Wallhagen et al. 2001; Pronk et al. 2011).

Furthermore, several studies have investigated the impact of a change in hearing on an individual's psychosocial health status. Faster decline in hearing ability in noise appeared to be associated with a stronger increase in social and emotional loneliness in older participants with moderate level of impairment at baseline (Pronk et al. 2014). In addition, the same study reported that emotional loneliness increased with hearing decline, predominantly for those who had recently lost their partner. A decline in hearing ability in noise appeared to be associated neither with a change in depression (Pronk et al. 2014) nor with a change in anxiety (thesis of Pronk 2013). Another study found no statistically significant differences in psychological distress over time between older participants with self-reported declining hearing and those with stable hearing status (Corna et al. 2009). Additional longitudinal studies investigating the change in hearing status and the simultaneous change in psychosocial health over time are needed to further clarify these relationships.

Apart from the commonly studied indicators, such as lone-

TABLE 1. Overview of longitudinal studies about the relationship between hearing status and psychosocial health

	Descriptive Information of the Studies					Longitudinal Relationship Between Hearing Status and:			
First Author (Year)	Study Population	Country	Follow-Up (Year)	Hearing Ability	Outcome Measure	Loneliness	Depression	Anxiety	Other Parameters of Psychosocial Health
Strawbridge et al. (2000)	50–102 yrs N = 2461	USA	1	Self-report 3 situations	DSM-III-R	Yes	Yes	-	-
Wallhagen et al. (2001)	50–102 yrs N = 2442	USA	1	Self-report 3 situations	DSM-III-R	Yes	Yes	-	-
Chou (2008)	>65 yrs N = 3782	England	2	Self-report 5-point scale	CES-D	-	No	-	-
Corna et al. (2009)	>50 yrs N = 1113	Canada	6	HUI 4 t-groups	Generalized distress	-	-	-	No relationship with distress
Saito et al. (2010)	>65 yrs N = 580	Japan	2–3	HHIE-S No vs. Yes	Geriatric depression scale	-	Yes	-	-
Pronk et al. (2011)	63–93 yrs N = 996/830	The Netherlands	4	Speech-in-Noise test Self-report	LON-scale CES-D	Yes, for subgroups	No	-	-
Gopinath et al. (2012)	49+ at T0 N = 2334	Australia	5	Audiometry	HHIE-S	-	Yes	-	Relationship with emotional distress
Kiely et al. (2013)	65–103 yrs N = 1611	Australia	16	Audiometry	CES-D	-	Yes	-	-
Pronk et al. (2014)	63–93 yrs N = 1178	The Netherlands	3–7	Speech-in-Noise test	LON-scale CES-D	Yes, for subgroups	No	No*	-

Results about anxiety as reported in the thesis of Pronk (2013).

CES-D, Center for Epidemiologic Studies Depression Scale; DSM-III-R, Diagnostic and Statistical Manual of Mental Disorders major depressive episodes scale; HHIE-S, Hearing Handicap Inventory for the Elderly Screening Version; HUI, Health Utility Index; LON-scale, De Jong Gierveld Loneliness scale.

JAMA Psychiatry | Original Investigation

Association of Higher Cortical Amyloid Burden With Loneliness in Cognitively Normal Older Adults

Nancy J. Donovan, MD; Olivia I. Okereke, MD, SM; Patrizia Vannini, PhD; Rebecca E. Amariglio, PhD; Dorene M. Rentz, PsyD; Gad A. Marshall, MD; Keith A. Johnson, MD; Reisa A. Sperling, MD

IMPORTANCE Emotional and behavioral symptoms in cognitively normal older people may be direct manifestations of Alzheimer disease (AD) pathophysiology at the preclinical stage, prior to the onset of mild cognitive impairment. Loneliness is a perceived state of social and emotional isolation that has been associated with cognitive and functional decline and an increased risk of incident AD dementia. We hypothesized that loneliness might occur in association with elevated cortical amyloid burden, an in vivo research biomarker of AD.

OBJECTIVE To determine whether cortical amyloid burden is associated with greater loneliness in cognitively normal older adults.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional analyses using data from the Harvard Aging Brain Study of 79 cognitively normal, community-dwelling participants. A continuous, aggregate measure of cortical amyloid burden, determined by Pittsburgh Compound B–positron emission tomography (PiB-PET), was examined in association with loneliness in linear regression models adjusting for age, sex, apolipoprotein E ε4 (APOEε4), socioeconomic status, depression, anxiety, and social network (without and with the interaction of amyloid and APOEε4). We also quantified the association of high amyloid burden (amyloid-positive group) to loneliness (lonely group) using logistic regression, controlling for the same covariates, with the amyloid-positive group and the lonely group, each composing 32% of the sample (n = 25).

MAIN OUTCOMES AND MEASURES Loneliness, as determined by the 3-item UCLA Loneliness Scale (possible range, 3-12, with higher score indicating greater loneliness).

RESULTS The 79 participants included 43 women and 36 men with a mean (SD) age of 76.4 (6.2) years. Mean (SD) cortical amyloid burden via PiB-PET was 1.230 (0.209), and the mean (SD) UCLA-3 loneliness score was 5.3 (1.8). Twenty-two (28%) had positive APOEε4 carrier status, and 25 (32%) were in the amyloid-positive group with cortical PiB distribution volume ratio greater than 1.2. Controlling for age, sex, APOEε4, socioeconomic status, depression, anxiety, and social network, we found that higher amyloid burden was significantly associated with greater loneliness: compared with individuals in the amyloid-negative group, those in the amyloid-positive group were 7.5-fold (95% CI, 1.7-fold to 34.0-fold) more likely to be classified as lonely than nonlonely ($\beta = 3.3$, partial $r = 0.4$, $P = .002$). Furthermore, the association of high amyloid burden and loneliness was stronger in APOEε4 carriers than in noncarriers.

CONCLUSIONS AND RELEVANCE We report a novel association of loneliness with cortical amyloid burden in cognitively normal older adults, suggesting that loneliness is a neuropsychiatric symptom relevant to preclinical AD. This work will inform new research into the neural underpinnings and disease mechanisms involved in loneliness and may enhance early detection and intervention research in AD.

Invited Commentary

Supplemental content

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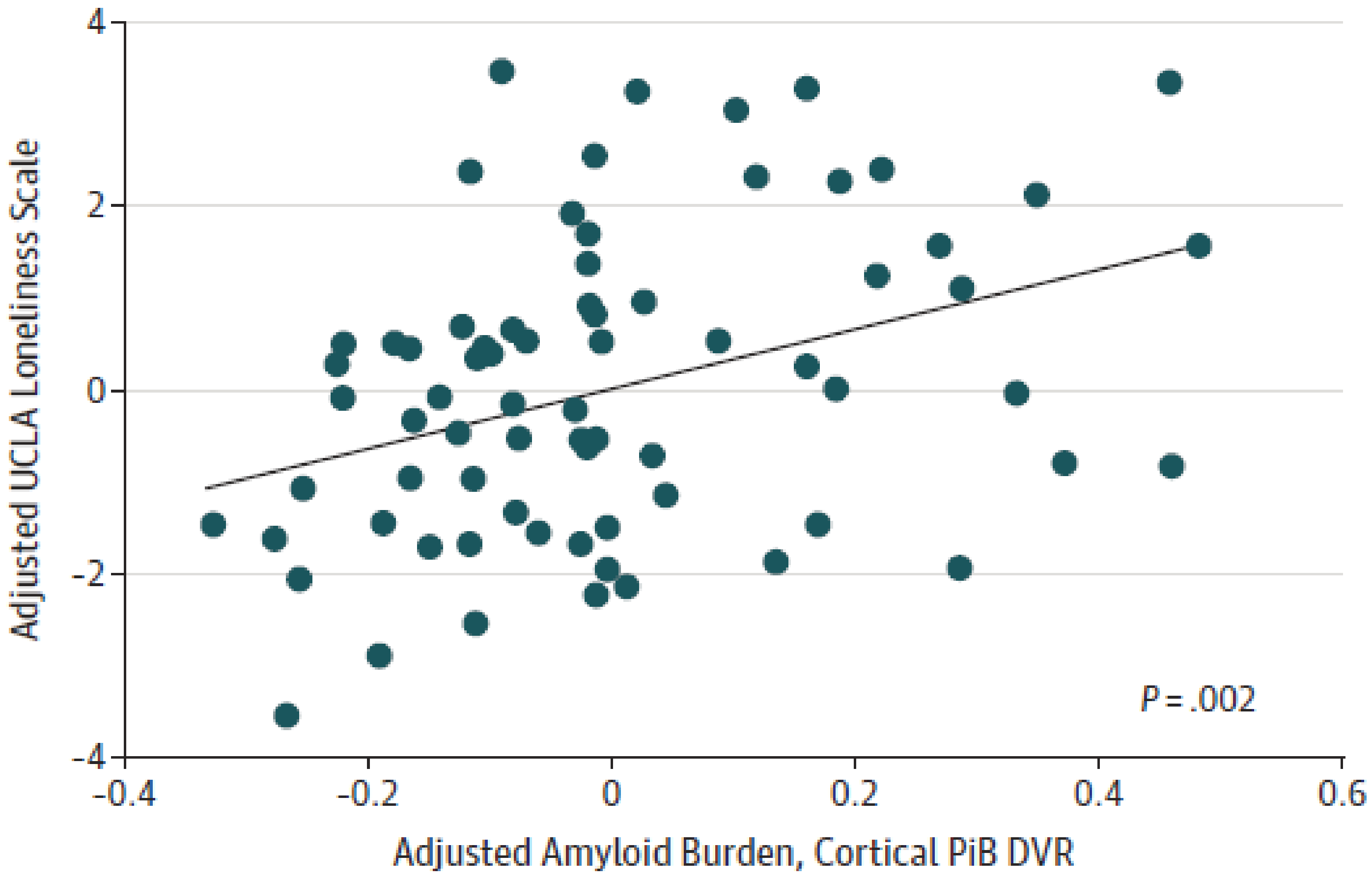
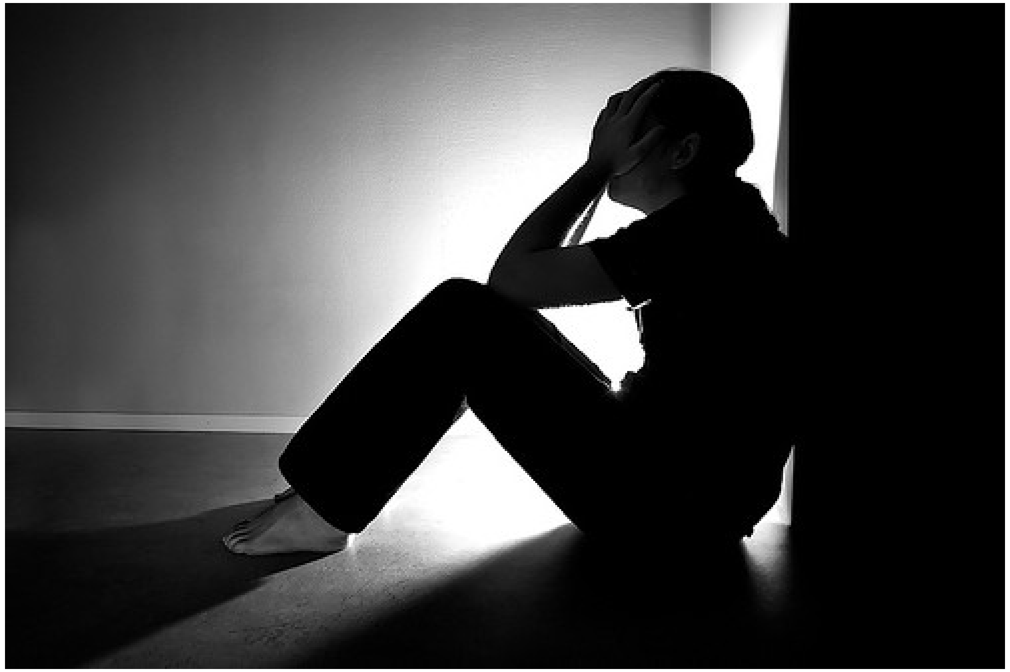
Figure. Cross-sectional Relation of Cortical Amyloid Burden and Loneliness



Multiple linear regression analysis was performed for loneliness, measured by the 3-item UCLA-3 Loneliness Scale (higher score indicates greater loneliness),



DEPRESSION

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Table 2. Stepwise Logistic Regression Models of the Odds of Major Depressive Disorder or Any Depressive Symptoms per 25 dB of Hearing Loss (HL) and Hearing Aid Use (HA)

	Major Depressive Disorder		Any Depressive Symptoms	
	BPTA per 25-dB HL	HA	BPTA per 25-dB HL	HA
Model	Odds Ratio (95% Confidence Interval)			
Base (HL + HA)	1.50 (0.74–3.04)	0.28 (0.13–0.60)[a]	1.63 (0.90–2.97)	0.27 (0.12–0.59)[a]
Base plus demographic factors	1.59 (0.63–4.03)	0.34 (0.14–0.83)[b]	1.54 (0.76–3.14)	0.34 (0.15–0.79)[b]
Base plus demographic and cardiovascular factors	1.63 (0.66–4.02)	0.35 (0.14–0.90)[b]	1.58 (0.77–3.25)	0.33 (0.14–0.77)[b]

BPTA=better ear pure tone average (per 25-dB loss). Hearing loss is defined as a speech-frequency pure tone average of hearing thresholds at 0.5, 1, 2, and 4 kHz in the better-hearing ear. Demographic factors include age, sex, race and ethnicity, and education; cardiovascular risk factors include hypertension, diabetes mellitus, smoking status, and stroke.

[a] $P < .001$.

[b] $P < .05$.

Mener DJ, Betz J, Genther DJ, Chen D, Lin FR. (2013) Hearing loss and depression in older adults. J Am Geriatr Soc 61(9):1627–29

Observational Study

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Increased risk of depression in patients with acquired sensory hearing loss

A 12-year follow-up study

Wei-Ting Hsu, MD[a], Chih-Chao Hsu, MD[b], Ming-Hsun Wen, MD[c], Hong-Ching Lin, MD[a,d], Hsun-Tien Tsai, MD, PhD[a], Peijen Su, MD, PhD[d,e], Chi-Te Sun, MSc[f], Cheng-Li Lin, MSc[g], Chung-Yi Hsu, MD, PhD[h], Kuang-Hsi Chang, PhD[i,*], Yi-Chao Hsu, PhD[j,*]

Abstract

Acquired sensory hearing loss (SHL) is suggested to be associated with depression. However, some studies have reported conflicting results. Our study investigated the relationship between the prevalence of SHL and the incidence of depression over 12 years of follow-up by using data from the Taiwan National Health Insurance Research Database (NHIRD). We sought to determine the association between SHL and subsequent development of depression and discuss the pathophysiological mechanism underlying the association.

Patients with SHL were identified from the NHIRD (SHL cohort). A non-SHL cohort, comprising patients without SHL frequency-matched with the SHL patients according to age group, sex, and the year of diagnosis of SHL at the ratio of 1:4, was constructed, and the incidence of depression was evaluated in both cohorts. A multivariable model was adjusted for age, sex, and comorbidity.

The SHL cohort and non-SHL cohort comprised 5043 patients with SHL and 20,172 patients without SHL, respectively. The incidences density rates were 9.50 and 4.78 per 1000 person-years in the SHL cohort and non-SHL cohort, respectively. After adjustment for age, sex, and comorbidities, the risk of depression was higher in the SHL cohort than in the non-SHL cohort (hazard ratio = 1.73, 95% confidence interval = 1.49–2.00).

Acquired SHL may increase the risk of subsequent depression. The results demonstrated that SHL was an independent risk factor regardless of sex, age, and comorbidities. Moreover, a strong association between hearing loss and subsequent depression among Taiwanese adults of all ages, particularly those aged ≤49 and >65 years and without using steroids for the treatment of SHL was observed. Prospective clinical and biomedical studies on the relationship between hearing loss and depression are warranted for determining the etiopathology.

Abbreviations: *5-HT* = 5-hydroxytryptamine, ADLs = activities of daily living, CAD = coronary artery disease, CI = confidence intervals, CKD = chronic kidney disease, COPD = chronic obstructive pulmonary disease, HR = hazard ratios, LHID200 = Longitudinal Health Insurance Database of 2000, NHI = National Health Insurance, NHIRD = National Health Insurance Research Database, SHL = Sensory Hearing Loss, SSRIs = selective serotonin reuptake inhibitors, US = United States.

Keywords: depression, NHIRD, sensory hearing loss

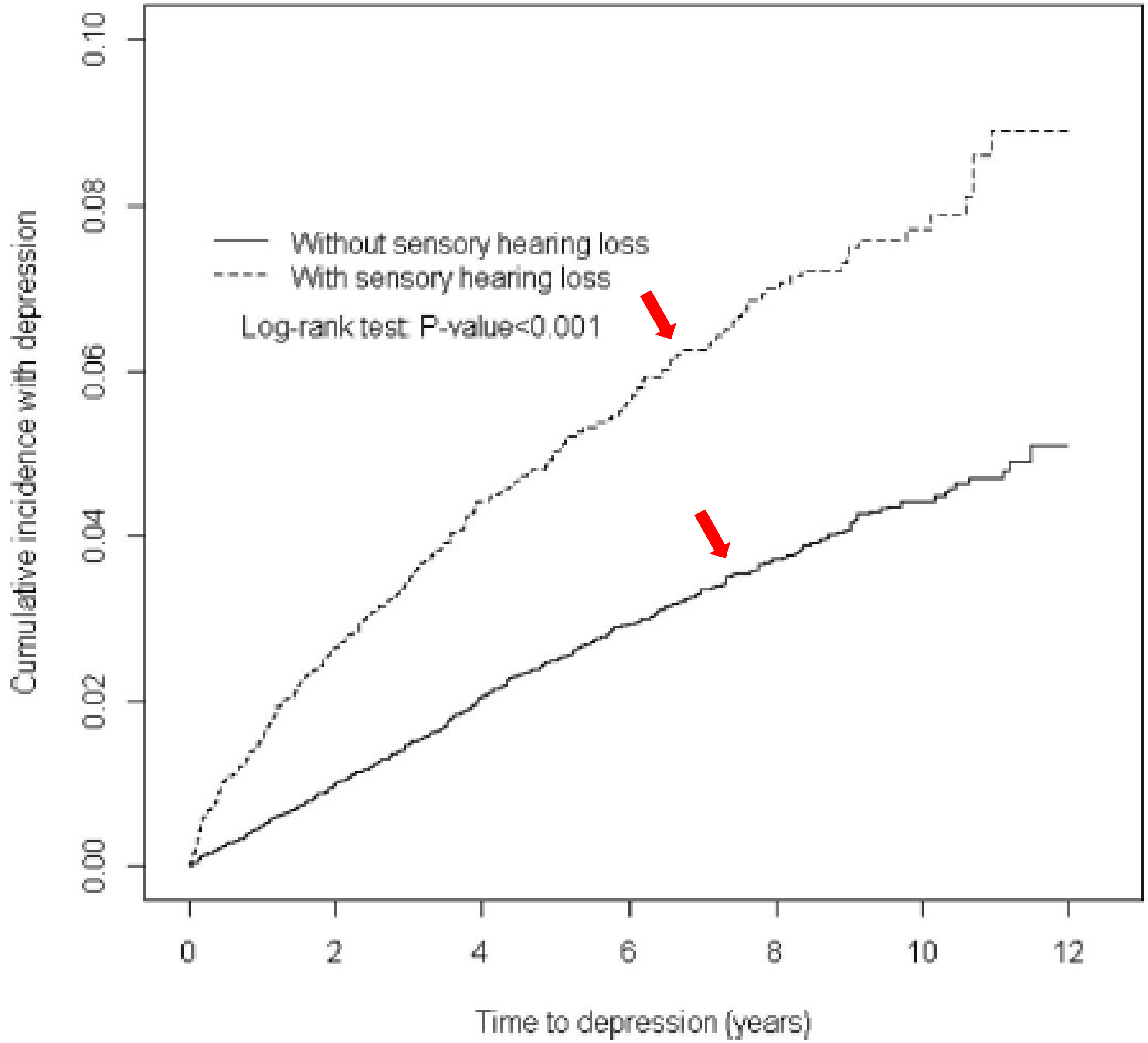

Figure 1. Cummulative incidence comparison of depression for patients with (dashed line) or without (solid line) sensory hearing loss.

Original Investigation

Hearing Impairment Associated With Depression in US Adults, National Health and Nutrition Examination Survey 2005-2010

Chuan-Ming Li, MD, PhD; Xinzhi Zhang, MD, PhD; Howard J. Hoffman, MA; Mary Frances Cotch, PhD; Christa L. Themann, MA, CCC-A; M. Roy Wilson, MD

IMPORTANCE Depression among hearing impaired US adults has not been studied previously.

OBJECTIVE To estimate the prevalence of and risk factors for depression among adults with hearing loss.

DESIGN, SETTING, AND PARTICIPANTS Adults aged 18 years or older (N = 18 318) who participated in the National Health and Nutrition Examination Survey (NHANES), 2005-2010, a nationally representative sample.

INTERVENTIONS Multistage probability sampling of US population.

MAIN OUTCOMES AND MEASURES Depression, assessed by the 9-item Patient Health Questionnaire (PHQ-9) scale, and hearing impairment (HI), assessed by self-report and audiometric examination for adults aged 70 years or older.

RESULTS The prevalence of moderate to severe depression (PHQ-9 score, ≥10) was 4.9% for individuals reporting excellent hearing, 7.1% for those with good hearing, and 11.4% for participants who reported a little trouble or greater HI. Using excellent hearing as the reference, after adjusting for all covariates, multivariate odds ratios (ORs) for depression were 1.4 (95% CI, 1.1-1.8) for good hearing, 1.7 (1.3-2.2) for a little trouble, 2.4 (1.7-3.2) for moderate trouble, 1.5 (0.9-2.6) for a lot of trouble, and 0.6 (0.1-2.6) for deaf. Moderate HI (defined by better ear pure-tone average of hearing thresholds at 0.5, 1, 2, and 4 kHz within the range 35- to 49-dB hearing level) was significantly associated with depression among older women (OR, 3.9; 95% CI, 1.3-11.3), after adjusting for age, sex, race/ethnicity, lifestyle characteristics, and selected health conditions.

CONCLUSIONS AND RELEVANCE After accounting for health conditions and other factors, including trouble seeing, self-reported HI and audiometrically determined HI were significantly associated with depression, particularly in women. Health care professionals should be aware of an increased risk for depression among adults with hearing loss.

JAMA Otolaryngol Head Neck Surg. 2014;140(4):293-302. doi:10.1001/jamaoto.2014.42
Published online March 6, 2014.

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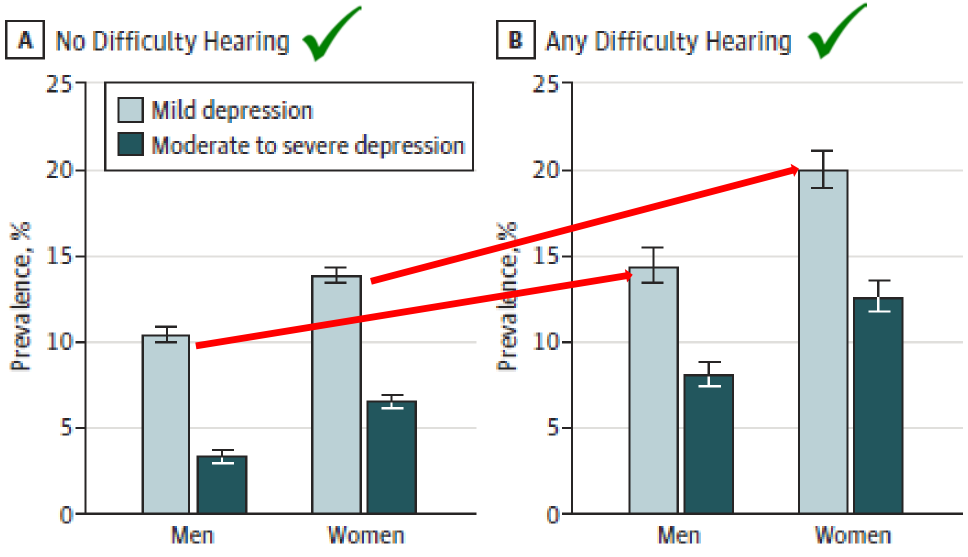
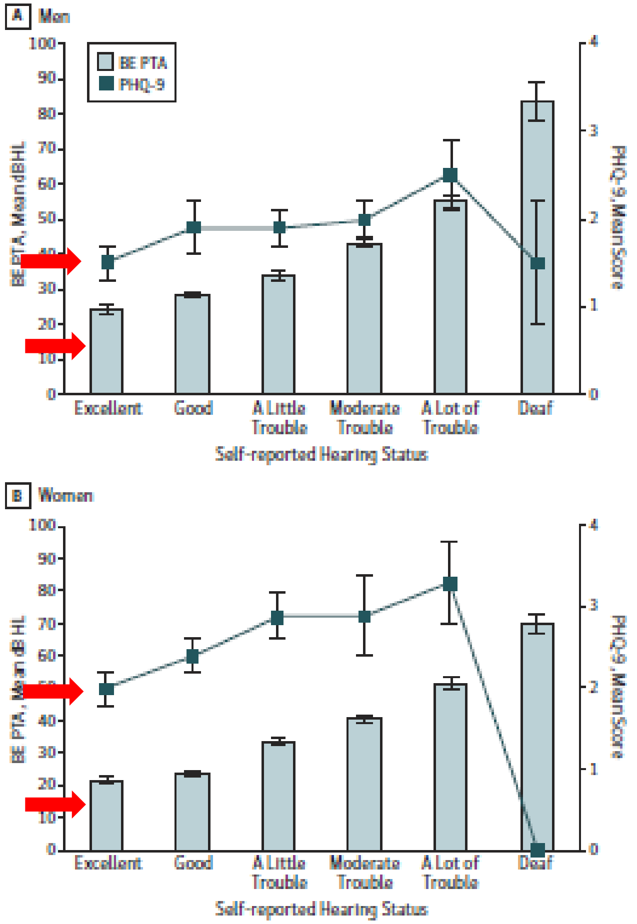
Figure 1. Prevalence of Depression Among US Adults by Sex and Reported Hearing Status, National Health and Nutrition Examination Survey 2005-2010



Limit lines indicate 95% CI.

Figure 2. Better Ear Pure-Tone Average (BE PTA) and 9-Item Patient Health Questionnaire (PHQ-9) Mean Score by Reported Hearing Status, National Health and Nutrition Examination Survey 2005-2006 and 2009-2010



Air conduction, BE PTA of thresholds at 0.5, 1, 2, and 4 kHz, measured in decibels hearing level (HL) scale, for men (A) and women (B) for US adults aged 70 years or older. Limit lines indicate 95% CI.

FALLS

Falls are the leading cause of fatal and non-fatal injuries among the elderly leading to significant health, social, economic, and emotional consequences

TABLE 3. Multivariate analyses of associations between hearing loss and cognition, social isolation, falls, hospitalizations, depression, and burden of physical and mental health

NHANES Cycle(s)	Outcome	n	Parameter Estimate*† (95% CI)	*p*
1999–2002	Digit Symbol Substitution Test score	516	−2.14 (−4.11, −0.18)	0.03
1999–2004	Social isolation‡ (ages 60–69 years)	839	1.52 (1.19, 1.93)	0.001
2004–2005	Social isolation (ages 70+ years)	465	1.08 (0.77, 1.52)	0.61
2001–2004	Any difficulty with falling in past year	1845	1.15 (0.92, 1.43)	0.21
2005–2006 and 2009–2010	Any hospitalization in past year	1064	1.15 (0.96,1.38)	0.13
	>10 days of poor physical health in past month	1004	1.22 (0.96,1.56)	0.10
	>10 days of poor mental health in past month	974	1.21 (0.92, 1.60)	0.17
	Moderate-severe depression (PHQ-9 score ≥ 10)	974	1.09 (0.84, 1.40)	0.51

The sample includes participants with normal hearing, unacknowledged hearing loss, or unaddressed hearing loss.
**OR per 10-dB increase in PTA in the better hearing ear were estimated for each outcome except the DSST, for which a β coefficient measuring average change in DSST per 10-dB increase in PTA was estimated.*
†All analyses were adjusted for age, sex, race/ethnicity, level of education, annual household income, and histories of diabetes, congestive heart disease, coronary artery disease, myocardial infarction, angina, stroke, smoking, and hypertension.
‡Social isolation defined by having at least two of the following: no close friends, no spouse or romantic partner, no one to provide emotional support, and no one to provide financial support.
CI, confidence interval; DSST, Digit Symbol Substitution Test; NHANES, National Health and Nutrition Examination Survey; OR, odds ratios; PHQ-9, 9-item Patient Health Questionnaire; PTA, pure-tone average.

Mick & Pichora-Fuller, 2016

Hearing Loss and Falls Among Older Adults in the United States

Identifying modifiable risk factors for falls in older adults is of significant public health importance. While hearing is not typically considered a risk factor for falls, a recent report of a cohort of older Finnish female twins demonstrated a strong association between audiometric hearing loss and incident falls.[1] Possible pathways that could explain this observed association include comcomitant cochlear and vestibular dysfunction, poor awareness of the auditory and spatial environment, or mediation through the effects of hearing loss on cognitive load and shared attention. The latter 2 pathways, which suggest a possible causal pathway between hearing loss and falling, are intriguing because hearing loss is highly prevalent but remains vastly undertreated in older adults.[2,3] The objective of this current study was to investigate the cross-sectional association of audiometric hearing loss with self-reported falls in a representative sample of the United States population aged

Results. From 2001 to 2004, a total of 2017 participants aged 40 to 69 years underwent concurrent assessment of hearing loss and fall history in NHANES (eTable). A hearing loss of greater than 25 dB was prevalent in 14.3% of these participants, and 4.9% of the participants reported falling over the preceding 12 months. We examined the association of hearing loss with having self-reported falls in stepwise logistic regression models. In an unadjusted model, hearing loss was significantly associated with the odds of reported falls. For every 10-dB increase in hearing loss, there was a 1.4-fold (95% CI, 1.3-1.5) increased odds of an individual reporting a fall over the preceding 12 months. Adjustment for demographic factors (age, sex, race, education), cardiovascular factors (smoking, diabetes, hypertension, stroke), and vestibular balance function did not substantially change the magnitude or significance of this association (**Table**). Restricting the analytical cohort only to those participants with a hearing loss of 40 dB or less (thereby excluding those with a moderate or severe hearing loss) did not affect the magnitude of our results (cf Table).

Lin FR, Ferrucci L. (2012). Hearing loss and falls among older adults in the United States. Arch Intern Med, 172(4):369-371

Table. Stepwise Logistic Regression Models of the Odds of Self-Reported Falls per 10 dB of Hearing Loss, National Health and Nutritional Examination Survey, 2001-2004

Variable[a]	N	Odds of Falling per 10 dB of Hearing Loss (95% CI)[b]
Base model (hearing loss only)	2017	1.4 (1.3-1.5)
Base + demographic factors	2016	1.5 (1.3-1.8)
Base + demographic factors + cardiovascular risk factors	1999	1.4 (1.2-1.7)
Base + demographic factors + cardiovascular risk factors + vestibular balance function	1674	1.6 (1.2-1.9)

[a] Demographic factors include age, sex, race/ethnicity, and education; cardiovascular risk factors include smoking status, diabetes mellitus, hypertension, and stroke; and vestibular balance function was assessed by condition 4 of the Modified Romberg Test of Standing Balance on Firm and Compliant Support Surfaces and was administered only to the 1684 study participants who passed the 3 prior easier test conditions.

[b] $P < .001$.

Lin FR, Ferrucci L. (2012). Hearing loss and falls among older adults in the United States. Arch Intern Med, 172(4):369-371

Falls

The magnitude of the association of hearing loss with falls is clinically-significant, with a 25-dB hearing loss (equivalent from going from normal to mild hearing loss) being associated with a nearly 3-fold increased odds of reporting a fall over the preceding year

Lin FR, Ferrucci L. (2012). Hearing loss and falls among older adults in the United States. Arch Intern Med, 172(4):369-371

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Hearing as a Predictor of Falls and Postural Balance in Older Female Twins

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Background. The purpose of the present study was to examine, first, whether hearing acuity predicts falls and whether the potential association is explained by postural balance and, second, to examine whether shared genetic or environmental effects underlie these associations.

Methods. Hearing was measured using a clinical audiometer as a part of the Finnish Twin Study on Aging in 103 monozygotic and 114 dizygotic female twin pairs aged 63–76 years. Postural balance was indicated as a center of pressure (COP) movement in semitandem stance, and participants filled in a fall-calendar daily for an average of 345 days after the baseline.

Results. Mean hearing acuity (better ear hearing threshold level at 0.5–4 kHz) was 21 dB (standard deviation [*SD*] 12). Means of the COP velocity moment for the best to the poorest hearing quartiles increased linearly from 40.7 mm^2/s (*SD* 24.4) to 52.8 mm^2/s (*SD* 32.0) (*p* value for the trend = .003). Altogether 199 participants reported 437 falls. Age-adjusted incidence rate ratios (IRRs) for falls, with the best hearing quartile as a reference, were 1.2 (95% confidence interval [CI] = 0.4–3.8) in the second, 4.1 (95% CI = 1.1–15.6) in the third, and 3.4 (95% CI = 1.0–11.4) in the poorest hearing quartiles. Adjustment for COP velocity moment decreased IRRs markedly. Twin analyses showed that the association between hearing acuity and postural balance was not explained by genetic factors in common for these traits.

Conclusion. People with poor hearing acuity have a higher risk for falls, which is partially explained by their poorer postural control. Auditory information about environment may be important for safe mobility.

Key Words: Hearing—Postural balance—Fall—Twin study—Heritability—Aging.

CARDIOVASCULAR DISEASE

Clinical Focus ■ *Grand Rounds*

The Influence of Cardiovascular Health on Peripheral and Central Auditory Function in Adults: A Research Review

Raymond H. Hull
Stacy R. Kerschen
Wichita State University, Wichita, KS

Purpose: This article provides a comparative review of research that has been conducted over the past 60+ years on the influence of cardiovascular health on the function of the peripheral and central auditory systems, and findings on the influence of improvements in cardiovascular health on those same systems.
Method: Research spanning the past 6 decades reviewed for this article has both hypothesized and confirmed the cardiovascular system's effects on the peripheral and central auditory systems. A review of the influence of the cardiovascular system is presented in this article, and a potential new avenue for auditory rehabilitation is postulated. The review presented in this article does not represent all studies conducted in the topic area but does provide an in-depth look into this fascinating area of research.

Conclusions: The negative influence of impaired cardiovascular health on both the peripheral and central auditory system and the potential positive influence of improved cardiovascular health on these same systems have been found through a sizable body of research that has been conducted over more than 6 decades. The most significant positive relationship between improved cardiovascular health and improvements in those auditory systems has been found among older adults. If that relationship continues to be confirmed, then a potential new avenue for auditory rehabilitation on behalf of adults who possess impaired auditory function may be discovered.

Key Words: cardiovascular disease, health, hearing, aging, peripheral and central auditory function

Hull & Kerschen (2010). Am J Audiol, 19, 9-16.

The Laryngoscope

CANDIDATE'S THESIS

Audiometric Pattern as a Predictor of Cardiovascular Status: Development of a Model for Assessment of Risk

David R. Friedland, MD, PhD; Christopher Cederberg, MD; Sergey Tarima, PhD

- Audiogram pattern correlates strongly with cerebrovascular and peripheral arterial disease and may represent a screening test for those at risk
- Patients with low-frequency hearing loss should be regarded as at risk for cardiovascular events, and appropriate referrals should be considered

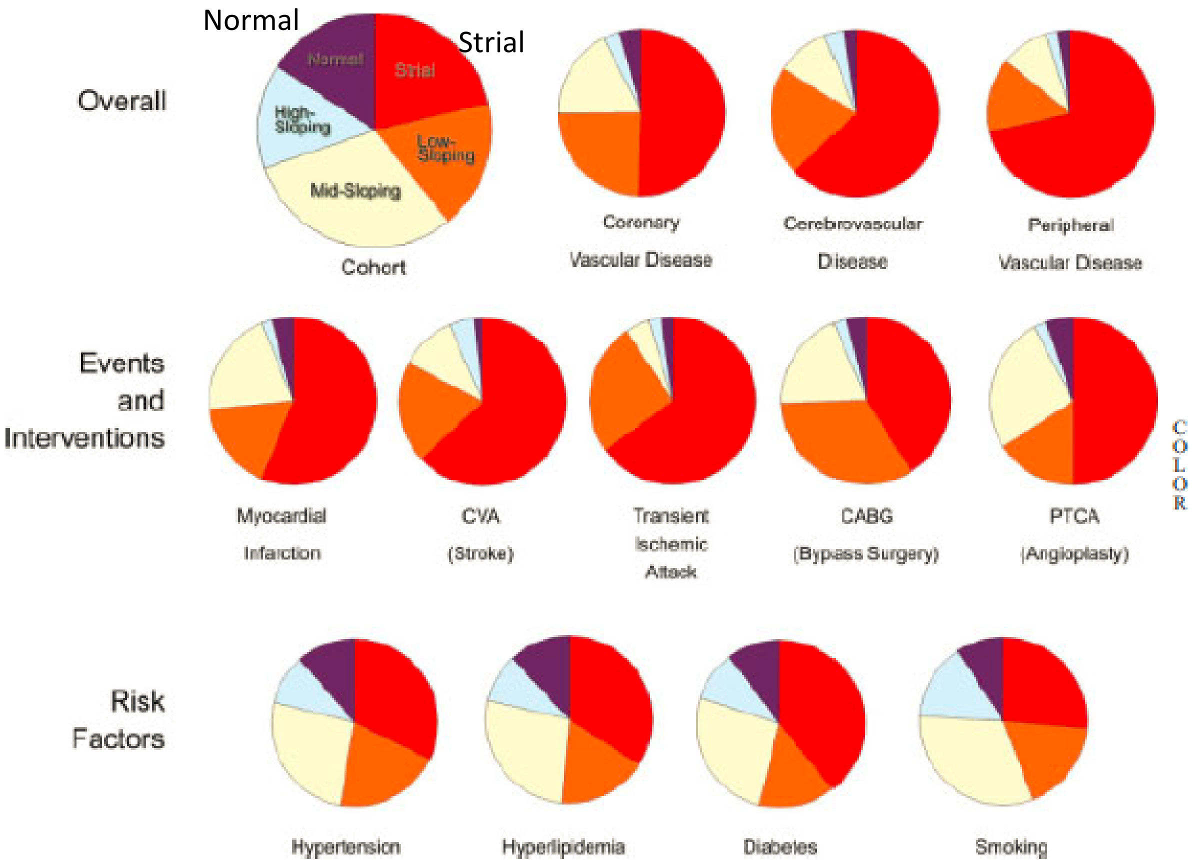

Fig. 4. The association between cardiovascular disease and audiometric pattern. Each pie chart shows the distribution of audiogram patterns for differing groups of patients. The larger initial pie chart shows the distribution of audiogram patterns in the cohort of 1,168 subjects. A particularly high incidence of low-frequency hearing loss (i.e., strial and low-sloping) is associated with cerebrovascular and peripheral vascular disease.

Friedland, D. R., Cederberg, C. and Tarima, S. (2009), Audiometric pattern as a predictor of cardiovascular status: Development of a model for assessment of risk. *Laryng, 119*:473–486.

Liljas, et al. (2016)

SENSORY IMPAIRMENTS AND CARDIOVASCULAR DISEASE INCIDENCE AND MORTALITY IN OLDER BRITISH COMMUNITY-DWELLING MEN: A 10-YEAR FOLLOW-UP STUDY

Table 1. Risk of Outcome According to Sensory Impairment in Men Aged 63 to 85 in 2003 from the British Regional Heart Study

	Incident CVD		Incident Myocardial Infarction		Incident Stroke		CVD Mortality	
Sensory Impairment	Rate/ 1,000 (n)	HR (95% CI)	Rate/ 1,000 (n)	HR (95% CI)	Rate/ 1,000 (n)	HR (95% CI)	Rate/ 1,000 (n)	HR (95% CI)
Hearing								
Could hear	17 (330)	1.00	9 (191)	1.00	7 (149)	1.00	10 (257)	1.00
Could hear, used aid	20 (59)	0.91 (0.68–1.20)	13 (40)	1.09 (0.77–1.55)	7 (23)	0.76 (0.49–1.19)	17 (68)	1.15 (0.88–1.51)
Could not hear, no aid	25 (69)	1.42 (1.09–1.84)[a]	13 (38)	1.35 (0.95–1.91)	11 (32)	1.46 (1.00–2.14)[a]	15 (52)	1.37 (1.02–1.85)[a]
Could not hear, used aid	22 (22)	1.10 (0.71–1.70)	14 (14)	1.26 (0.73–2.17)	8 (8)	0.88 (0.43–1.80)	15 (20)	1.11 (0.71–1.76)
Vision								
Could see	18 (467)	1.00	10 (273)	1.00	8 (209)	1.00	12 (383)	1.00
Poor vision	24 (16)	1.20 (0.73–1.97)	16 (11)	1.41 (0.77–2.57)	7 (5)	0.85 (0.35–2.06)	19 (17)	1.42 (0.87–2.30)
Dual								
Could hear and could see	17 (326)	1.00	9 (185)	1.00	8 (151)	1.00	10 (254)	1.00
Dual impairment	26 (8)	1.40 (0.69–2.83)	13 (4)	1.23 (0.46–3.31)	13 (4)	1.52 (0.56–4.12)	22 (9)	1.73 (0.89–3.36)

[a]Remained statistically significant after further adjustment for social class, obesity, smoking, physical activity, hypertension, and diabetes mellitus.
CVD = cardiovascular disease; HR = hazard ratio; CI = confidence interval.

Previous research suggests that the associations between hearing impairment and CVD could be attributed to smoking and atherosclerosis, but in the current study, the associations remained significant after adjustment for smoking and CVD-related comorbidities

Proceedings

Audiology & Neurotology

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Contributing Determinants to Hearing Loss in Elderly Men and Women: Results from the Population-Based Rotterdam Study

Stephanie C. Rigters[a] Mick Metselaar[a] Marjan H. Wieringa[a]
Robert J. Baatenburg de Jong[a] Albert Hofman[b] André Goedegebure[a]

Departments of [a]Otorhinolaryngology/Audiology and [b]Epidemiology, Erasmus MC – University Center Rotterdam, Rotterdam, The Netherlands

- Hearing loss was associated with age, education, systolic blood pressure, diabetes mellitus, BMI, smoking, and alcohol consumption (inverse correlation)
- Results were different for low- and high-frequency loss among men and women, suggesting that different mechanisms are involved in the etiology of ARHL
- A healthy lifestyle, e.g. without smoking or being overweight, may contribute to less hearing loss at an older age

CLINICAL RESEARCH STUDY

THE AMERICAN JOURNAL of MEDICINE®

Hypertension, Diuretic Use, and Risk of Hearing Loss

Brian M. Lin, MD,[a,b,c] **Sharon G. Curhan, MD, ScM,**[b,c] **Molin Wang, PhD,**[b,d,e] **Roland Eavey, MD,**[f] **Konstantina M. Stankovic, MD, PhD,**[a,c] **Gary C. Curhan, MD, ScD**[b,c,d,g]

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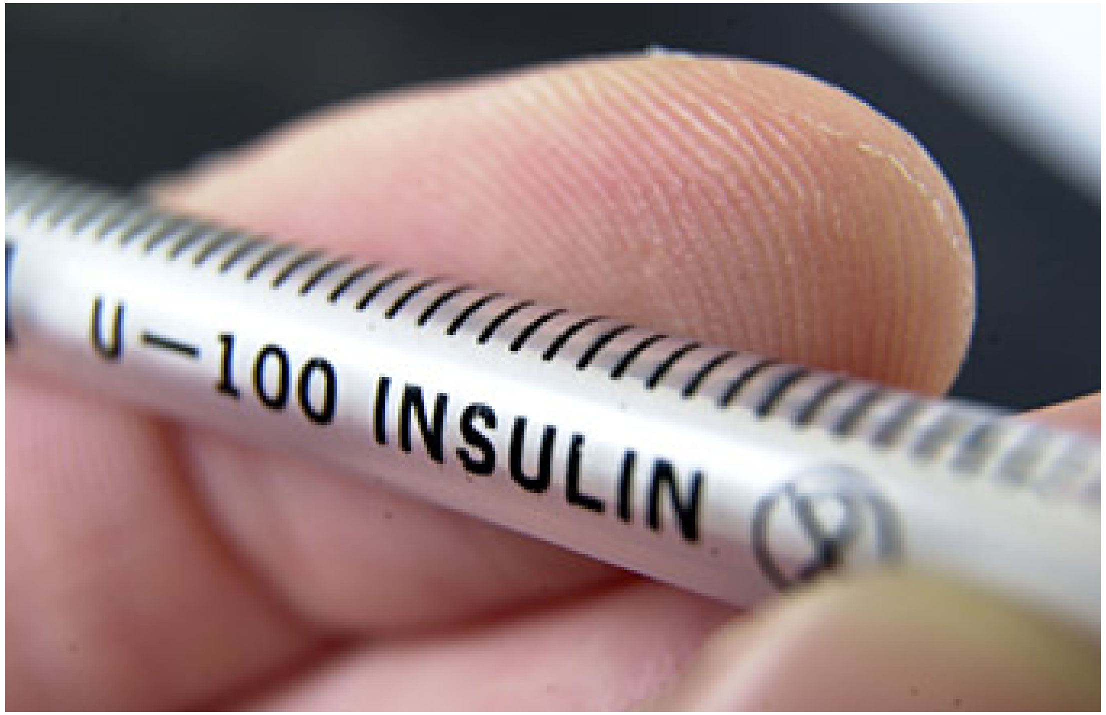
CLINICAL SIGNIFICANCE

- Hypertension is independently associated with a higher risk of hearing loss in women.
- Use of thiazide diuretics and furosemide is not independently associated with risk of hearing loss in women.



DIABETES

Diabetes and Risk of Hearing Impairment in Adults: A Meta-Analysis

Chika Horikawa, Satoru Kodama, Shiro Tanaka, Kazuya Fujihara, Reiko Hirasawa, Yoko Yachi, Hitoshi Shimano, Nobuhiro Yamada, Kazumi Saito, and Hirohito Sone

Department of Hematology, Endocrinology, and Metabolism (C.H., S.K., K.F., R.H., Y.Y., H.So.), Niigata University Faculty of Medicine, 951-8510 Japan; Department of Internal Medicine (C.H., K.F., H.Sh., N.Y.), University of Tsukuba Institute of Clinical Medicine, 305-8575 Japan; Translational Research Center (S.T.), Kyoto University Hospital, Kyoto, 606-8507 Japan; and Ibaraki Prefectural University of Health Sciences Center for Medical Sciences (K.S.), Amimachi, Inashikigun, Ibaraki, 300-0394, Japan

Context: Recently, several studies have investigated the relationship between diabetes and hearing impairment, but results were inconsistent.

Objective: Our objective was to compare the prevalence of hearing impairment between diabetic and nondiabetic adults.

Data Sources : We performed a systematic literature search using MEDLINE (1950 to May 30, 2011) and EMBASE (1974 to May 30, 2011).

Study Selection: Cross-sectional studies were included if data on numbers of hearing-impaired and non-hearing-impaired cases with diabetes were presented. Hearing impairment was limited to that assessed by pure-tone audiometry that included at least 2 kHz of frequency range and was defined as progressive, chronic, sensorineural, or without specified cause.

Data Extraction: Two authors independently extracted relevant data. Odd ratios (ORs) of hearing impairment related to diabetes calculated in each study were pooled with the random-effects model.

Data Synthesis: Data were obtained from 13 eligible studies (20,194 participants and 7,377 cases). Overall pooled OR (95% confidence interval) of hearing impairment for diabetic participants compared with nondiabetic participants was 2.15 (1.72–2.68). OR was higher in younger participants (mean age, ≤60 yr) than in those over 60 yr among which the OR remained significant (2.61 and 1.58, $P = 0.008$). The strength of the association between diabetes and prevalence of hearing impairment was not significantly influenced by whether participants were matched for age and gender ($P = 0.68$) or whether participants chronically exposed to noisy environments were excluded ($P = 0.19$).

Conclusions: Current meta-analysis suggests that the higher prevalence of hearing impairment in diabetic patients compared with nondiabetic patients was consistent regardless of age. (*J Clin Endocrinol Metab* 98: 51–58, 2013)

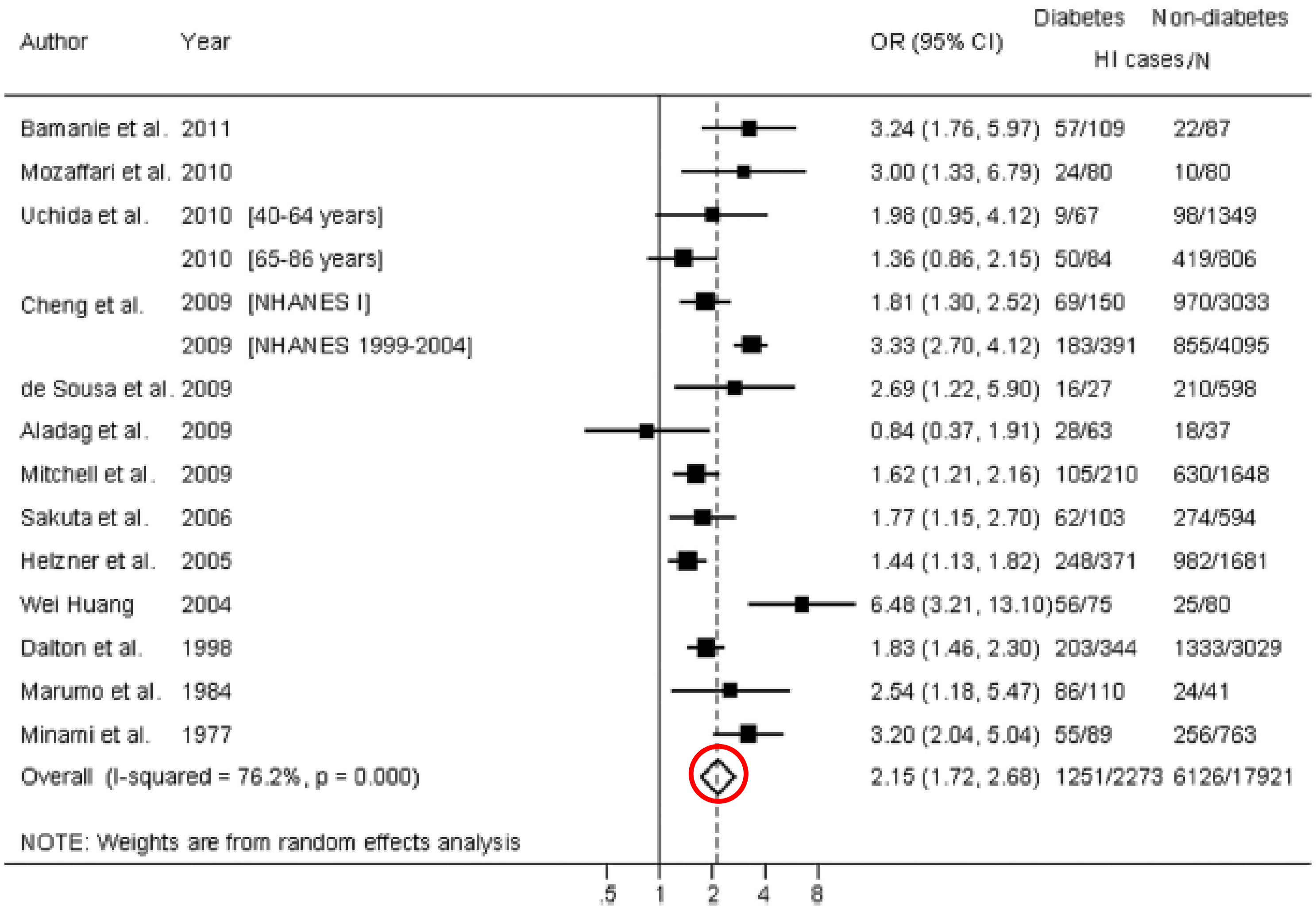


FIG. 2. Forest plot of ORs of hearing impairment (HI) for diabetic participants compared with nondiabetic participants. The size of *squares* reflects the statistical weight of each study. Pooled OR is indicated by *unshaded diamond*.

Horikawa C, Kodama S, Tanaka S, Fujihara K, Hirasawa R,Yachi Y, Shimano H, et al. (2012). Diabetes and risk of hearing impairment in adults: A meta-analysis. J Clin Endocrin Metab, 98(1):51-8.

Annals of Internal Medicine | Article

Diabetes and Hearing Impairment in the United States: Audiometric Evidence from the National Health and Nutrition Examination Survey, 1999 to 2004

Kathleen E. Bainbridge, PhD, MPH; Howard J. Hoffman, MA; and Catherine C. Cowie, PhD, MPH

Background: Diabetes might affect the vasculature and neural system of the inner ear, leading to hearing impairment.

Objective: To determine whether hearing impairment is more prevalent among U.S. adults with diabetes.

Design: Cross-sectional analysis of nationally representative data.

Setting: National Health and Nutrition Examination Survey, 1999 to 2004.

Participants: 5140 noninstitutionalized adults age 20 to 69 years who had audiometric testing.

Measurements: Hearing impairment was assessed from the pure tone average of thresholds over low or mid-frequencies (500, 1000, and 2000 Hz) and high frequencies (3000, 4000, 6000, and 8000 Hz) and was defined as mild or greater severity (pure tone average >25 decibels hearing level [dB HL]) and moderate or greater severity (pure tone average >40 dB HL).

Results: Hearing impairment was more prevalent among adults with diabetes. Age-adjusted prevalence of low- or mid-frequency hearing impairment of mild or greater severity in the worse ear was 21.3% (95% CI, 15.0% to 27.5%) among 399 adults with diabetes compared with 9.4% (CI, 8.2% to 10.5%) among 4741 adults without diabetes. Similarly, age-adjusted prevalence of high-frequency hearing impairment of mild or greater severity in the worse ear was 54.1% (CI, 45.9% to 62.3%) among those with diabetes compared with 32.0% (CI, 30.5% to 33.5%) among those without diabetes. The association between diabetes and hearing impairment was independent of known risk factors for hearing impairment, such as noise exposure, ototoxic medication use, and smoking (adjusted odds ratios for low- or mid-frequency and high-frequency hearing impairment were 1.82 [CI, 1.27 to 2.60] and 2.16 [CI, 1.47 to 3.18], respectively).

Limitations: The diagnosis of diabetes was based on self-report. The investigators could not distinguish between type 1 and type 2 diabetes. Noise exposure was based on participant recall.

Conclusion: Hearing impairment is common in adults with diabetes, and diabetes seems to be an independent risk factor for the condition.

Ann Intern Med. 2008;149:1-10. www.annals.org
For author affiliations, see end of text.

Table 6. **Multivariable-Adjusted Odds Ratios***

Hearing Impairment	Participants, *n*	Odds Ratio (95% CI)
Worse ear		
Mild or greater severity (PTA threshold >25 dB HL)		
Low or mid-frequency†	491	1.82 (1.27–2.60)
High frequency†	1537	2.16 (1.47–3.18)
Moderate or greater severity (PTA threshold >40 dB HL)		
Low or mid-frequency	154	1.81 (1.09–3.02)
High frequency†	815	2.29 (1.52–3.44)
Better ear		
Mild or greater severity (PTA threshold >25 dB HL)		
Low or mid-frequency	203	1.80 (1.14–2.85)
High frequency	1025	2.44 (1.65–3.61)
Moderate or greater severity (PTA threshold >40 dB HL)		
Low or mid-frequency	44	3.21 (1.63–6.29)
High frequency	475	1.64 (1.04–2.57)
Self-reported	949	1.76 (1.30–2.38)

dB HL = decibels hearing level; PTA = pure tone average.
* For the association of diagnosed diabetes and hearing impairment in U.S. adults age 20–69 years. Data from the National Health and Nutrition Examination Survey, 1999–2004 (*n* = 4471). Odds ratios are adjusted for age, sex, race or ethnicity, education, income–poverty ratio, leisure-time noise exposure, occupational noise exposure, military history, use of ototoxic medications, and smoking.
† Model did not pass the Hosmer–Lemeshow goodness-of-fit test, but examination of residuals and observed and expected values did not suggest an important departure from model fit.

Bainbridge KE, Hoffman HJ, Cowie CC. (2008). Diabetes and hearing impairment in the United States: Audiometric evidence from the National Health and Nutrition Examination Survey, 1999-2004. *Ann Intern Med, 149*(1):1-10

Otology & Neurotology
27:37–43 © 2005, Otology & Neurotology, Inc.

A 5-Year Prospective Study of Diabetes and Hearing Loss in a Veteran Population

*Nancy Vaughan, *†Kenneth James, *Daniel McDermott, *†Susan Griest, and *Stephen Fausti

**VA National Center for Rehabilitative Auditory Research, Portland Veterans Affairs Medical Center and †Oregon Health and Sciences University, Portland, Oregon, U.S.A.*

Hypothesis: Veterans with diabetes will have significantly greater hearing loss than nondiabetic veterans.
Background: The association between diabetes and hearing loss remains unclear despite the volume of research that has been devoted to the question. Often, differences in hearing thresholds between diabetic and nondiabetic patients are confounded by age and noise exposure.
Methods: In this 5-year prospective study, 342 diabetic veterans and 352 nondiabetic veterans from the Portland VA Medical Center in Oregon were tested on a variety of audiometric measures, including pure-tone thresholds.
Results: Age and noise exposure were accounted for in the analyses. There was a trend toward greater hearing loss in diabetic patients 60 years of age and younger across the frequency range. These differences were statistically significant only in the highest frequencies tested (10, 12.5, 14, and 16 kHz). The effects of both diabetes and noise exposure on high-frequency hearing thresholds were dependent on age. For patients older than 60 years, the mean thresholds were not significantly different.
Conclusion: These results suggest that diabetic patients 60 years old or younger may show early high-frequency hearing loss similar to early presbycusis. After age 60, difference in hearing loss between diabetic and nondiabetic patients was reduced. **Key Words:** Diabetes—Hearing loss—Hemoglobin A1c—Insulin—Pure-tone threshold.

Otol Neurotol **27:**37–43, 2006.

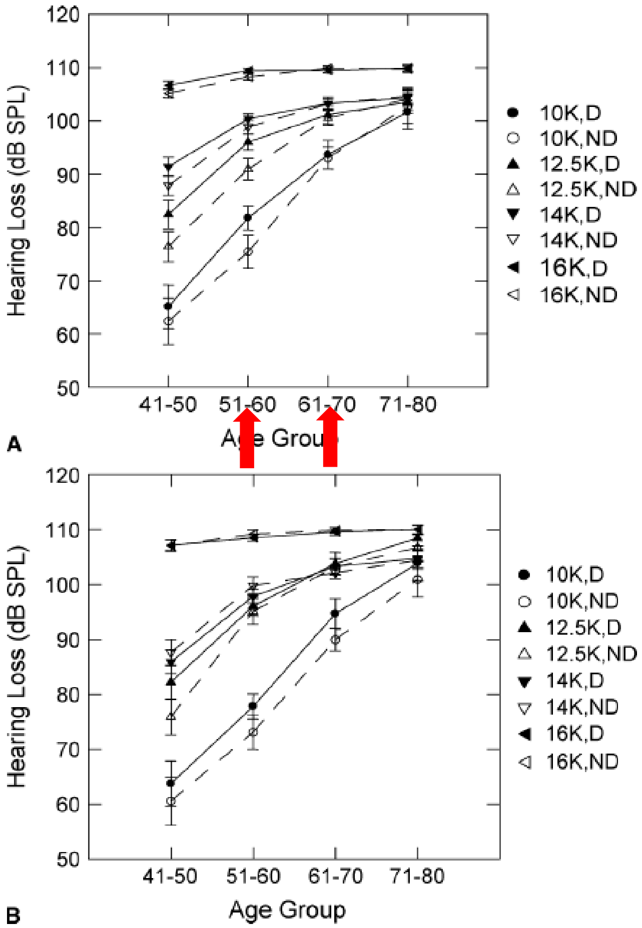


FIG. 2. (*A*) Right ear pure-tone thresholds versus age for patients with diabetes (D) and nondiabetics (ND) tested at 10 to 16 kHz. Nonoverlapping error bars indicate significant differences ($p < 0.05$) between diabetic and nondiabetic means. (*B*) Left ear pure-tone thresholds versus age for diabetic (D) and nondiabetic (ND) patients tested at 10 to 16 kHz. Nonoverlapping error bars indicate significant differences ($p < 0.05$) between diabetic and nondiabetic means.

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Original article

Original article

Diabetes mellitus and the incidence of hearing loss: a cohort study

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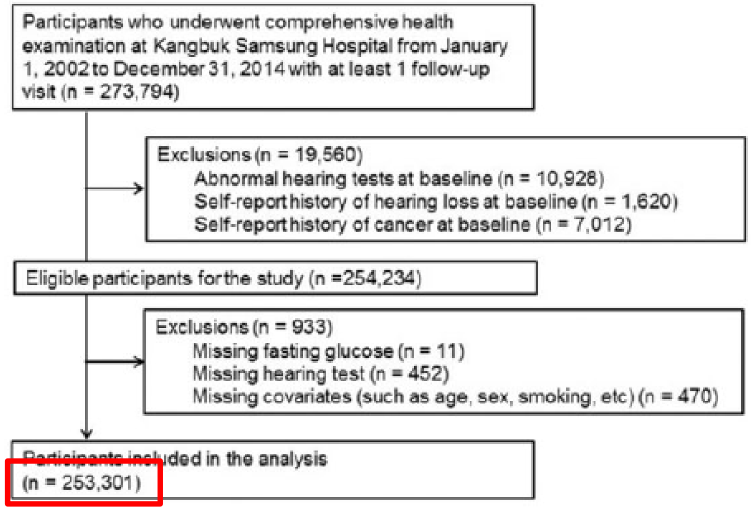


Figure 1. Flow chart of study design.

Table 2. Adjusted hazard ratios for incident hearing loss associated with baseline diabetes status

	Events/number of participants	Incidence rate (per 1000 person-years)	Model 1[a]	Model 2[b]	Model 3[c]
Diabetes defined by glucose					
Normal	1855/200 649	1.8	*Reference*	*Reference*	*Reference*
Pre-diabetes	699/46 132	3.1	1.10 (1.00, 1.20)	1.04 (0.95, 1.14)	1.04 (0.95, 1.14)
Diabetes	263/6520	9.2	1.48 (1.29, 1.69)	1.40 (1.22, 1.60)	1.36 (1.19, 1.56)
Diabetes defined by glucose and HbA1c					
Normal	1292/161 224	1.7	*Reference*	*Reference*	*Reference*
Pre-diabetes	888/63 548	3.3	1.10 (1.00, 1.20)	1.04 (0.95, 1.14)	1.03 (0.95, 1.13)
Diabetes	287/7284	9.7	1.50 (1.31, 1.72)	1.39 (1.21, 1.59)	1.36 (1.18, 1.56)

[a]Model 1: Adjusted for age spline, sex, study centre and year of visit.
[b]Model 2: Further adjusted for exposure to occupational noise, body mass index, smoking, alcohol and vigorous exercise.
[c]Model 3: Further adjusted for total and HDL cholesterol, triglycerides and hypertension.

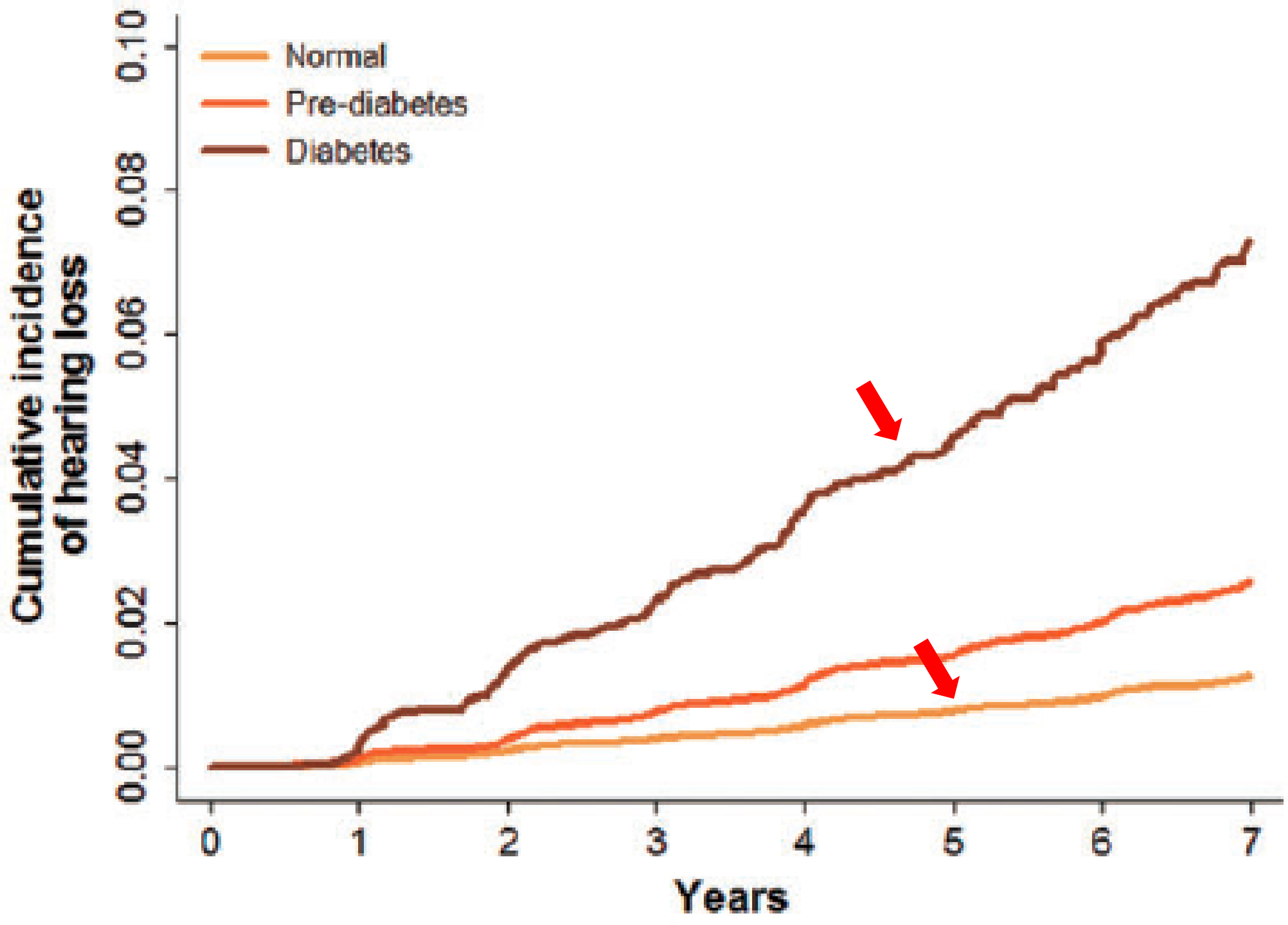


Figure 2. Cumulative incidence of incident hearing loss by baseline diabetes status.

- In this large cohort study, participants with DM had a moderately increased risk of incident hearing loss
- Higher levels of HbA1c, representing higher long-term glucose levels and poor glycemic control, were progressively associated with hearing-loss risk
- The association of DM with hearing loss was stronger in younger (<50 years) than in older participants

AJA

Research Note

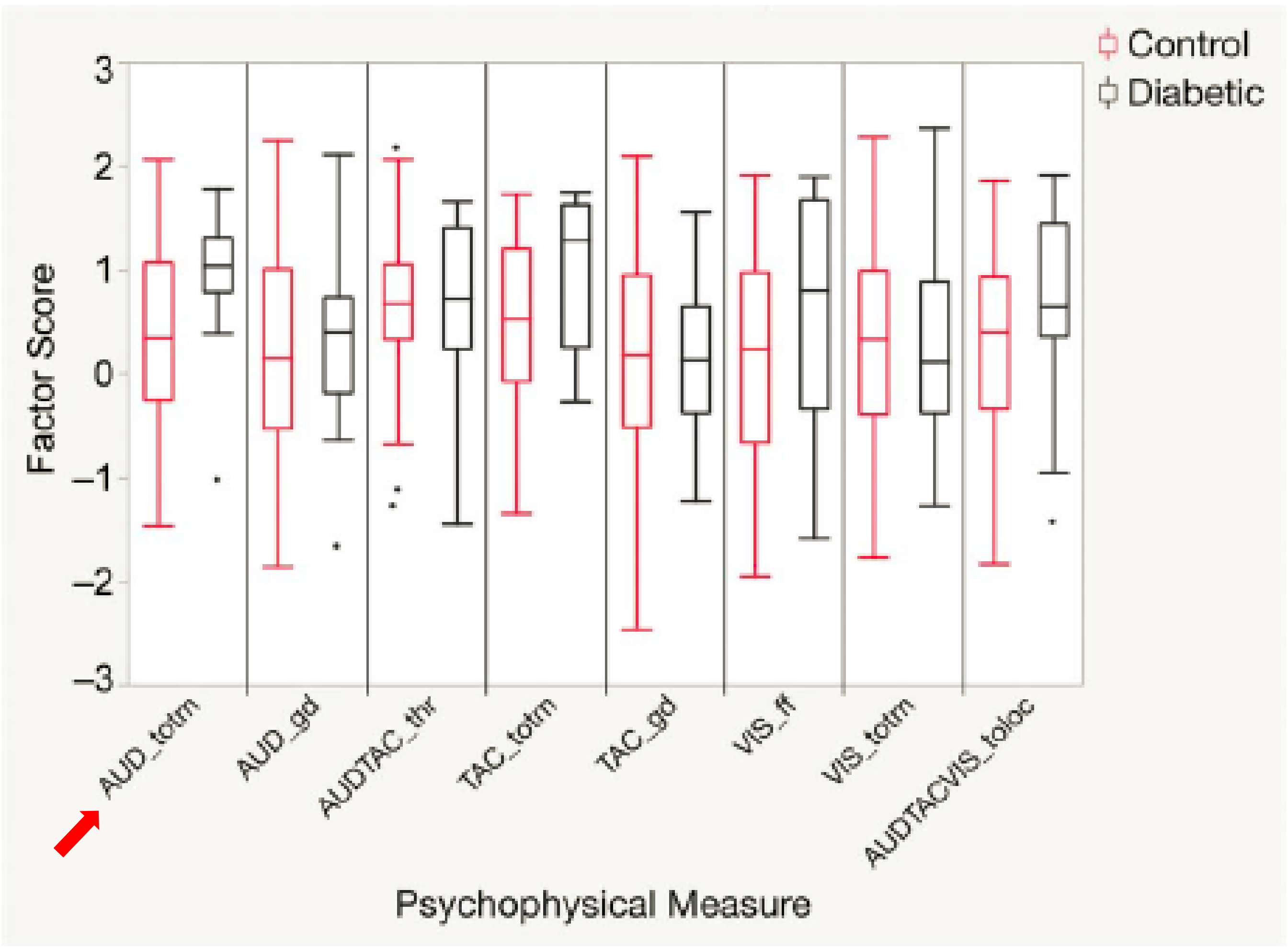
A Retrospective Examination of the Effect of Diabetes on Sensory Processing in Older Adults

Larry E. Humes[a]

Purpose: The purpose of this article is to examine retrospectively the impact of diabetes mellitus on auditory, visual, and tactile processing in older adults.
Method: Fourteen (10.4%) of a sample of 135 older adults self-reported the presence of diabetes mellitus in a study of sensory and cognitive processing across the adult lifespan. In this study, the performance of the subgroup with diabetes on a number of psychophysical sensory-processing measures was compared with that of the 121 older adults without diabetes. Measures of sensory processing focused on temporal processing and threshold sensitivity in each of 3 sensory modalities: hearing, vision, and touch.
Results: The subgroup of older adults with diabetes differed significantly ($p < .05$) from the larger group without diabetes only for measures of auditory temporal-order and temporal-masking identification tasks.
Conclusion: This retrospective study provides additional evidence in support of higher level auditory-processing deficits in older adults with a positive history of diabetes mellitus.

Humes, L. (2016). Amer J Audiolol, 25, 364-367. doi:10.1044/2016_AJA-16-0034

Figure 1. Tukey boxplots show the medians (horizontal line within box) and interquartile ranges (upper, 75th percentile, and lower, 25th percentile, bounds of each box) for the 14 older adults with self-reported diabetes (black) and the 121 older adults with no reports of diabetes (red) for each of eight measures of sensory processing. The error bars represent the range unless some data points fell outside the boundaries set by 1.5 times the interquartile range (IQR) below the 25th percentile or 1.5 × IQR above the 75th percentile. When data points fell outside this range, the error bars were set to the corresponding 1.5 × IQR boundary and the resulting outliers appear as dots. Each of the eight measures of sensory processing appears on the *x*-axis and the measures were identified through factor analyses of the data from the full dataset of 245 adults in Humes et al. (2013). For each of the eight measures, the initial sets of capital letters indicate the sensory modality: AUD = auditory, TAC = tactile, and VIS = visual. The lowercase letters following the underscore denote the nature of the task: totm = temporal order, temporal masking; gd = gap detection; thr = threshold sensitivity; ff = flicker fusion; and toloc = temporal order locate. The latter was a special version of the temporal-order identification task in which the participant only needed to determine the location sequence of two stimulus presentations (left-right or right-left) rather than identify the specific vowels, letters, or tactile patterns in the sequence.



Hearing Loss & Diabetes

It is believed that, overtime, high blood glucose levels can damage the vessels in the stria vascularis and nerves, impacting the biochemistry and neural innervation in the cochlea

DEMENTIA

ORIGINAL CONTRIBUTION

Hearing Loss and Incident Dementia

Frank R. Lin, MD, PhD; E. Jeffrey Metter, MD; Richard J. O'Brien, MD, PhD; Susan M. Resnick, PhD; Alan B. Zonderman, PhD; Luigi Ferrucci, MD, PhD

Objective: To determine whether hearing loss is associated with incident all-cause dementia and Alzheimer disease (AD).

Design: Prospective study of 639 individuals who underwent audiometric testing and were dementia free in 1990 to 1994. Hearing loss was defined by a pure-tone average of hearing thresholds at 0.5, 1, 2, and 4 kHz in the better-hearing ear (normal, <25 dB [n=455]; mild loss, 25-40 dB [n=125]; moderate loss, 41-70 dB [n=53]; and severe loss, >70 dB [n=6]). Diagnosis of incident dementia was made by consensus diagnostic conference. Cox proportional hazards models were used to model time to incident dementia according to severity of hearing loss and were adjusted for age, sex, race, education, diabetes mellitus, smoking, and hypertension.

Setting: Baltimore Longitudinal Study of Aging.

Participants: Six hundred thirty-nine individuals aged 36 to 90 years.

Main Outcome Measure: Incident caces of all-cause dementia and AD until May 31, 2008.

Results: During a median follow-up of 11.9 years, 58 cases of incident all-cause dementia were diagnosed, of which 37 cases were AD. The risk of incident all-cause dementia increased log linearly with the severity of baseline hearing loss (1.27 per 10-dB loss; 95% confidence interval, 1.06-1.50). Compared with normal hearing, the hazard ratio (95% confidence interval) for incident all-cause dementia was 1.89 (1.00-3.58) for mild hearing loss, 3.00 (1.43-6.30) for moderate hearing loss, and 4.94 (1.09-22.40) for severe hearing loss. The risk of incident AD also increased with baseline hearing loss (1.20 per 10 dB of hearing loss) but with a wider confidence interval (0.94-1.53).

Conclusions: Hearing loss is independently associated with incident all-cause dementia. Whether hearing loss is a marker for early-stage dementia or is actually a modifiable risk factor for dementia deserves further study.

Arch Neurol. 2011;68(2):214-220

Table 2. Demographic and Clinical Characteristics of Baseline Study Cohort by Incident Dementia[a]

	No Dementia (n=581)	Dementia (n=58)	Univariate HR (95% CI)
Hearing loss, mean (SD), PTA[b]	18.8 (13.9)	32.6 (17.0)	1.1 (1.0-1.1)[c]
Hearing loss[d]			
Normal	435 (74.9)	20 (34.5)	1 [Reference]
Mild	104 (17.9)	21 (36.2)	4.9 (2.6-8.8)
Moderate	38 (6.5)	15 (25.9)	12.1 (6.2-23.9)
Severe	4 (0.7)	2 (3.4)	21.9 (5.1-94.2)

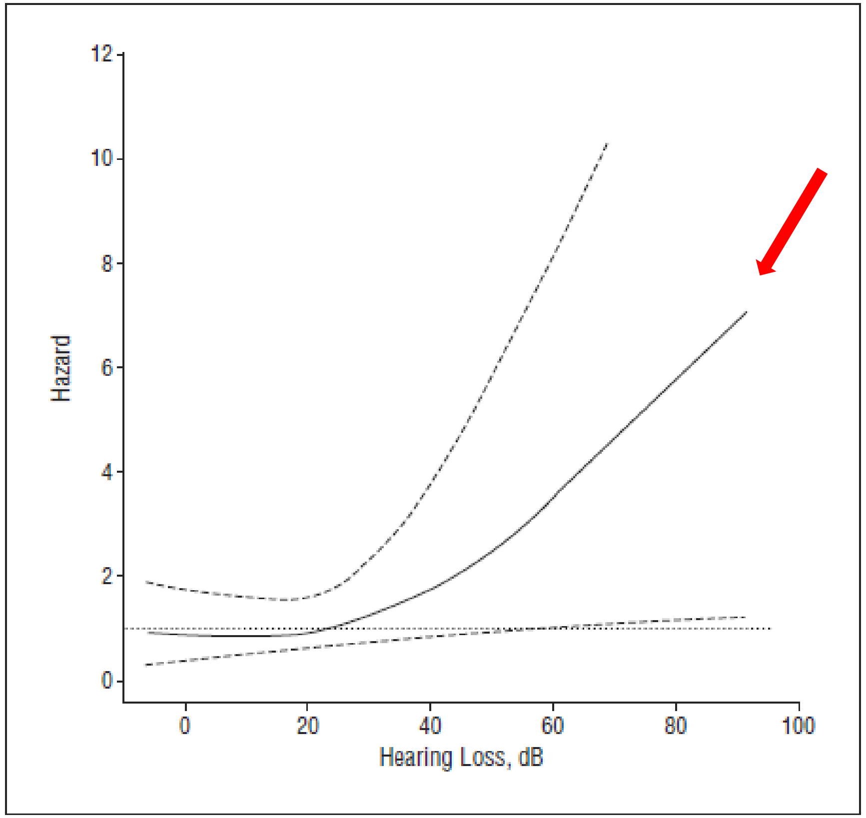


Figure 2. Risk of incident all-cause dementia by baseline hearing loss after adjustment for age, sex, race, education, diabetes mellitus, smoking, and hypertension. Hearing loss is defined by the pure-tone average of thresholds at 0.5, 1, 2, and 4 kHz in the better-hearing ear. Upper and lower dashed lines correspond to the 95% confidence interval.

Lin FR, Metter J, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L. (2011) Hearing loss and incident dementia. Arch Neurol, 68(2):214-20.

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Relationship of Hearing loss and Dementia: a Prospective, Population-based Study

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Abstract

Objective—To determine whether baseline hearing loss increases cognitive decline and risk for all-cause dementia in a population of elderly individuals.

Study design—Longitudinal cohort study

Setting—Community-based, outpatient

Patients—Men and women aged 65 years or older without dementia at baseline

Intervention(s)—All subjects completed the Modified Mini-Mental Status Exam (3MS-R) at baseline and over 3 triennial follow-up visits. Hearing loss (HL) at baseline was based on observation of hearing difficulties during testing or interview. Incident dementia was determined by clinical assessment and expert consensus.

Main outcome measure(s)—Dementia and 3MS-R score.

Results—At baseline 4,463 subjects were without dementia, 836 of whom had HL. Of those with HL, 16.3% developed dementia, compared to 12.1% of those without HL ($p<0.001$). Mean time to dementia was 10.3 years in the HL group vs. 11.9 years for non-HL (Log Rank test $p<0.001$). In Cox regression analyses controlling for gender, presence of APOE- ε4 allele, education, and baseline age, and cardiovascular risk factors, HL was an independent predictor of developing dementia (Hazard ratio = 1.27, p=0.026 (95% CI = 1.03, 1.56). Linear mixed models controlling for similar covariates showed HL was associated with faster decline on the 3MS-R, at a rate of 0.26 points/year worse than those without HL.

Conclusions—Elderly individuals with HL have an increased rate of developing dementia and more rapid decline on 3MS-R scores than their non-hearing impaired counterparts. These findings suggest that hearing impairment may be a marker for cognitive dysfunction in adults age 65 and older.

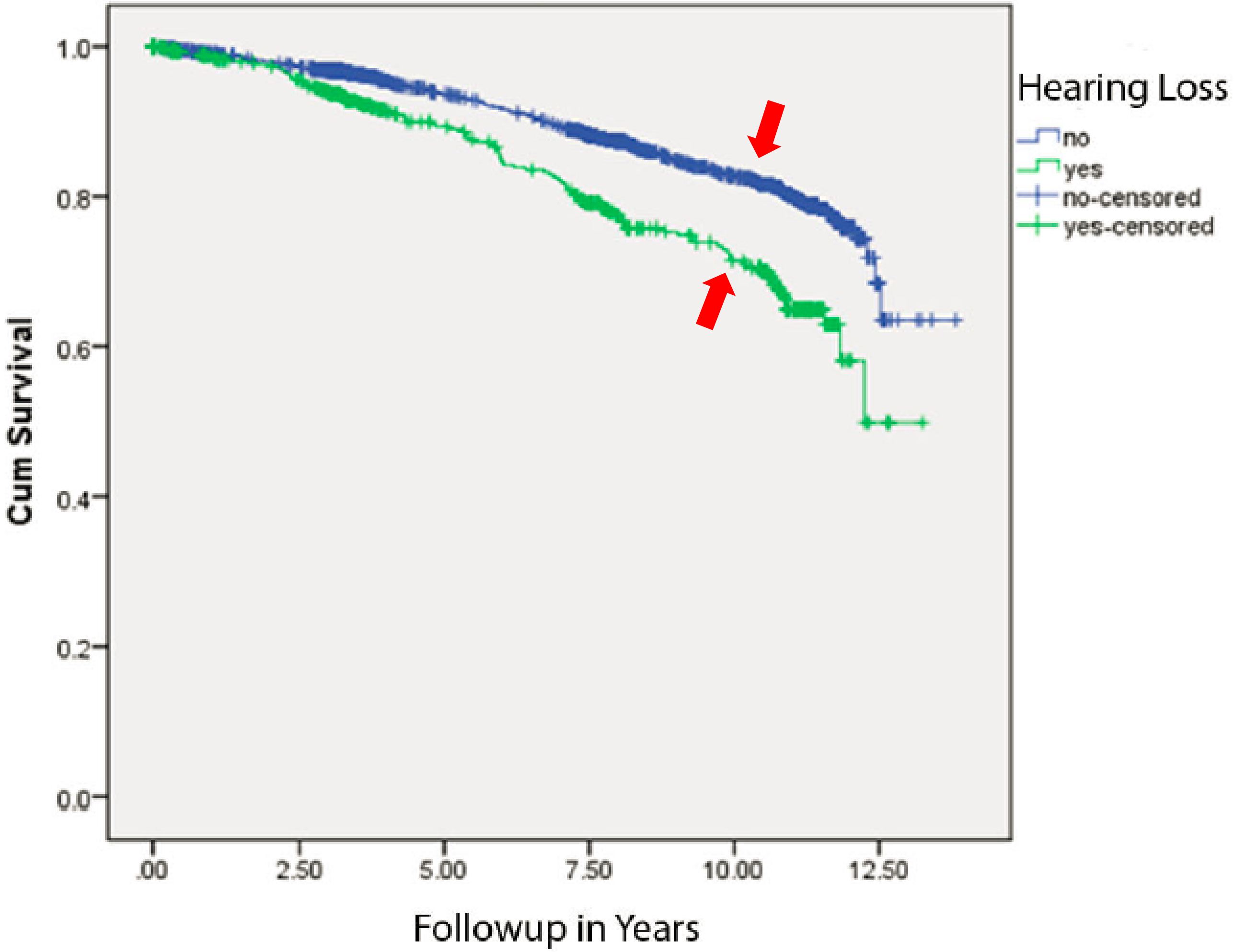

Figure 2.

This Kaplan-Meier plot shows time to dementia in years of follow up ("cumulative survival") based on baseline hearing status. Those with hearing loss depicted on the lower line had a higher rate of incident dementia ($p<0.001$).

RESEARCH ARTICLE

Hearing Impairment Affects Dementia Incidence. An Analysis Based on Longitudinal Health Claims Data in Germany

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Fritze T, Teipel S, Óvári A, Kilimann I, Witt G, Doblhammer G (2016) Hearing Impairment Affects Dementia Incidence. An Analysis Based on Longitudinal Health Claims Data in Germany. PLoSONE 11(7): e0156876. doi:10.1371/journal.pone.0156876

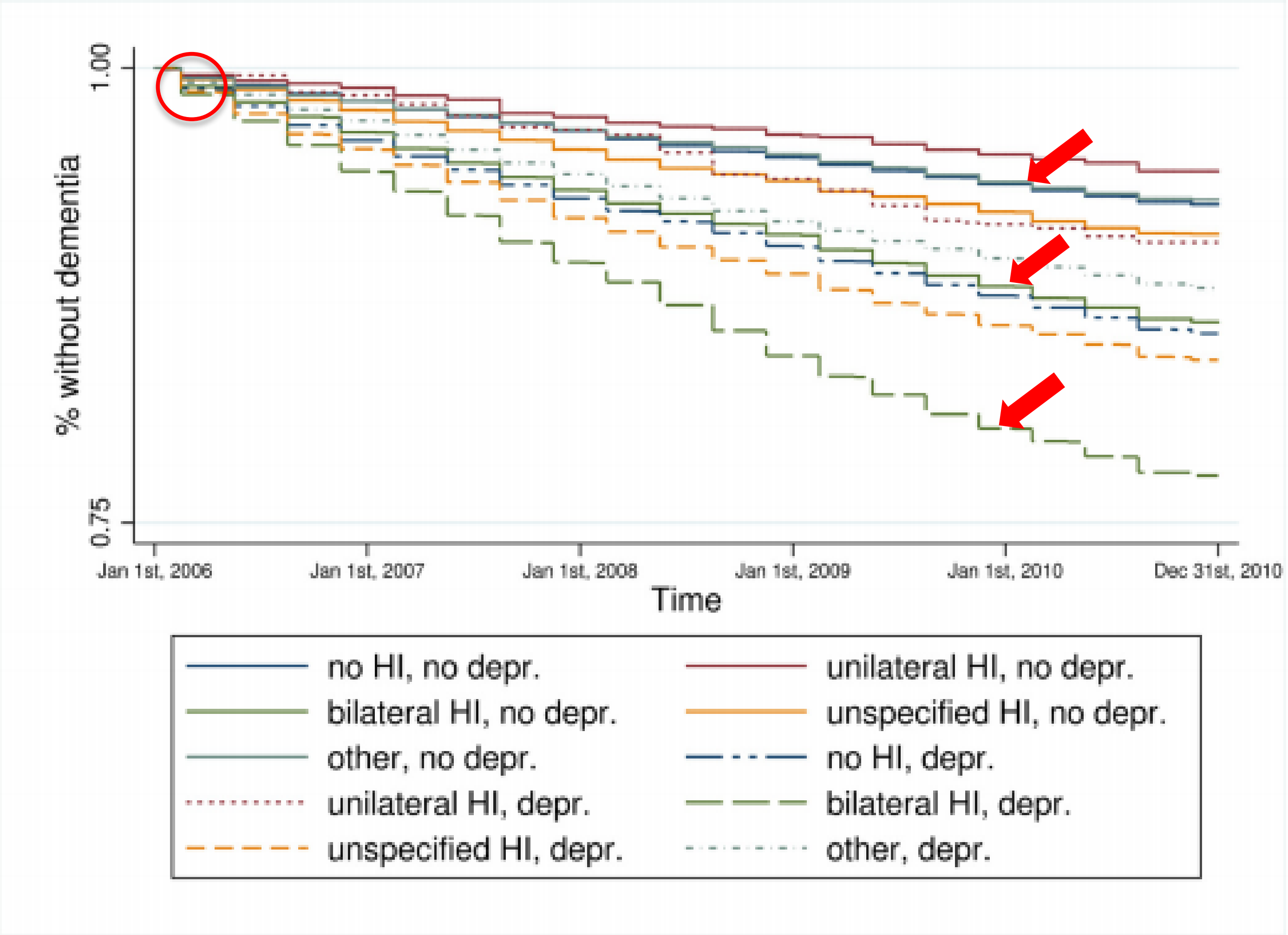


Fig 4. Kaplan-Meier estimator of time to dementia incidence by hearing impairment and depression.
Data source: Claims data AOK 2006–2010; $p_{log\ rank}<0.001$.

Fritze T, Teipel S, Óvári A, Kilimann I, Witt G, Doblhammer G (2016) Hearing Impairment Affects Dementia Incidence. An Analysis Based on Longitudinal Health Claims Data in Germany. PLoS ONE 11(7): e0156876. doi:10.1371/journal.pone.0156876

Dementia & Hearing Loss

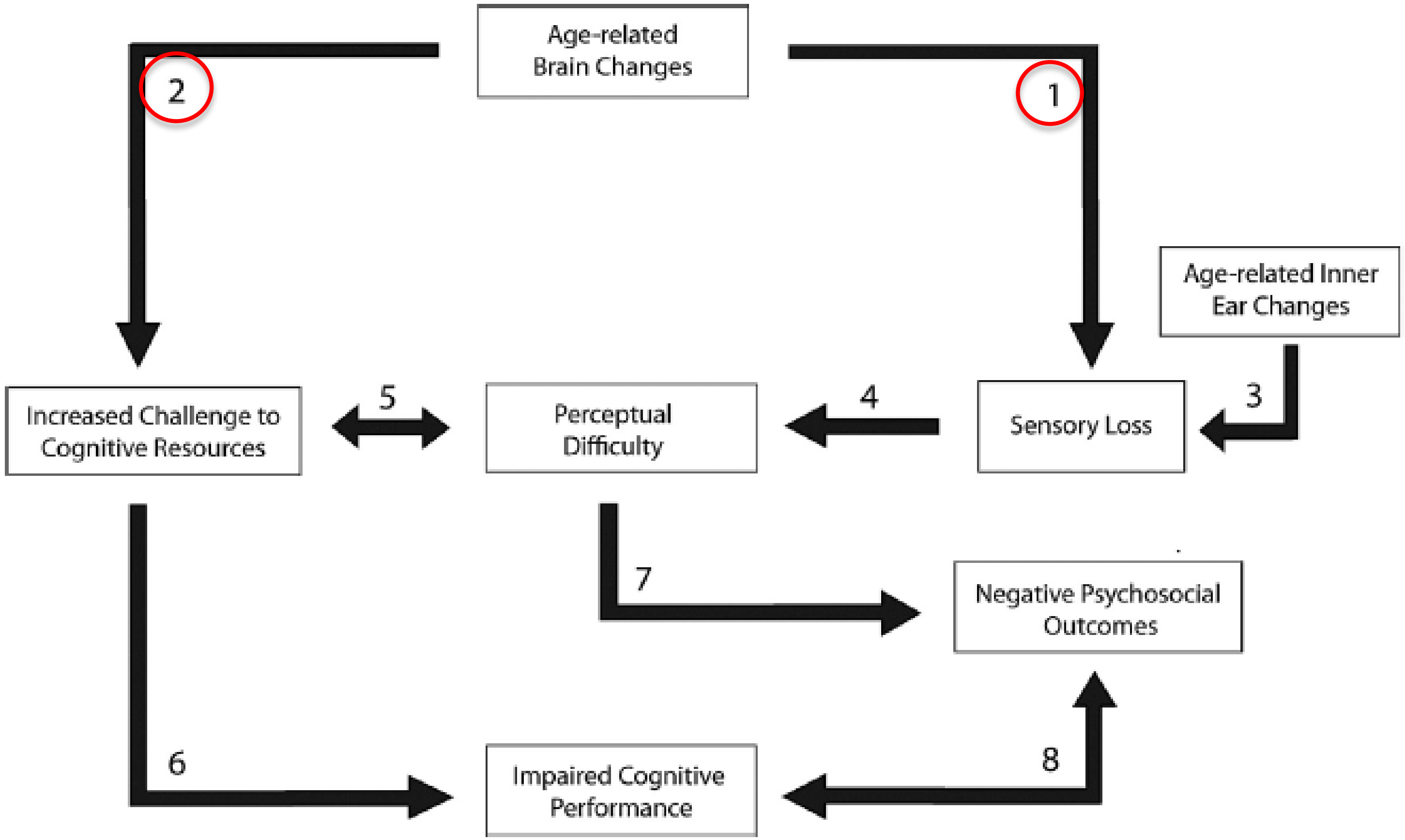


Fig. 2. An alternative framework for conceptualizing the relationship between hearing loss and cognitive decline.

Wayne RV, Johnsrude IS. (2015) A review of causal mechanisms underlying the link between age-related hearing loss and cognitive decline. Age Res Rev, 23:154–166

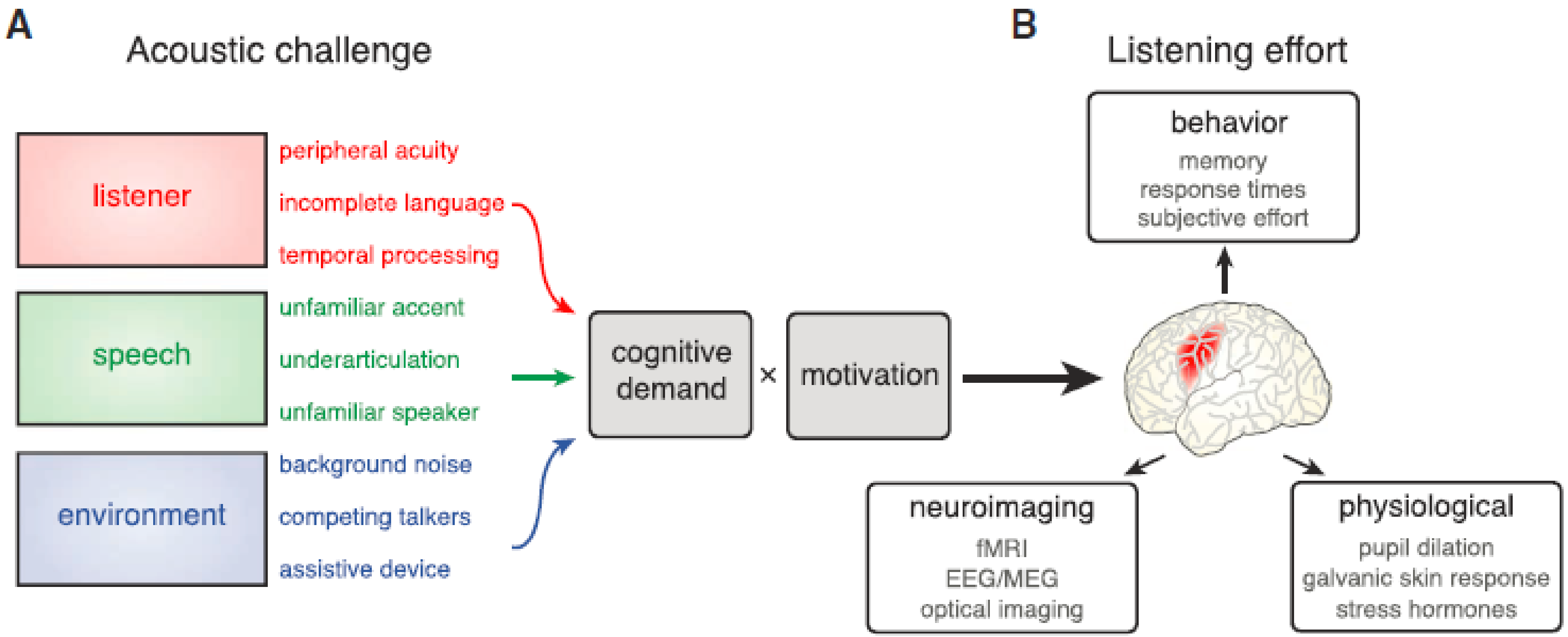
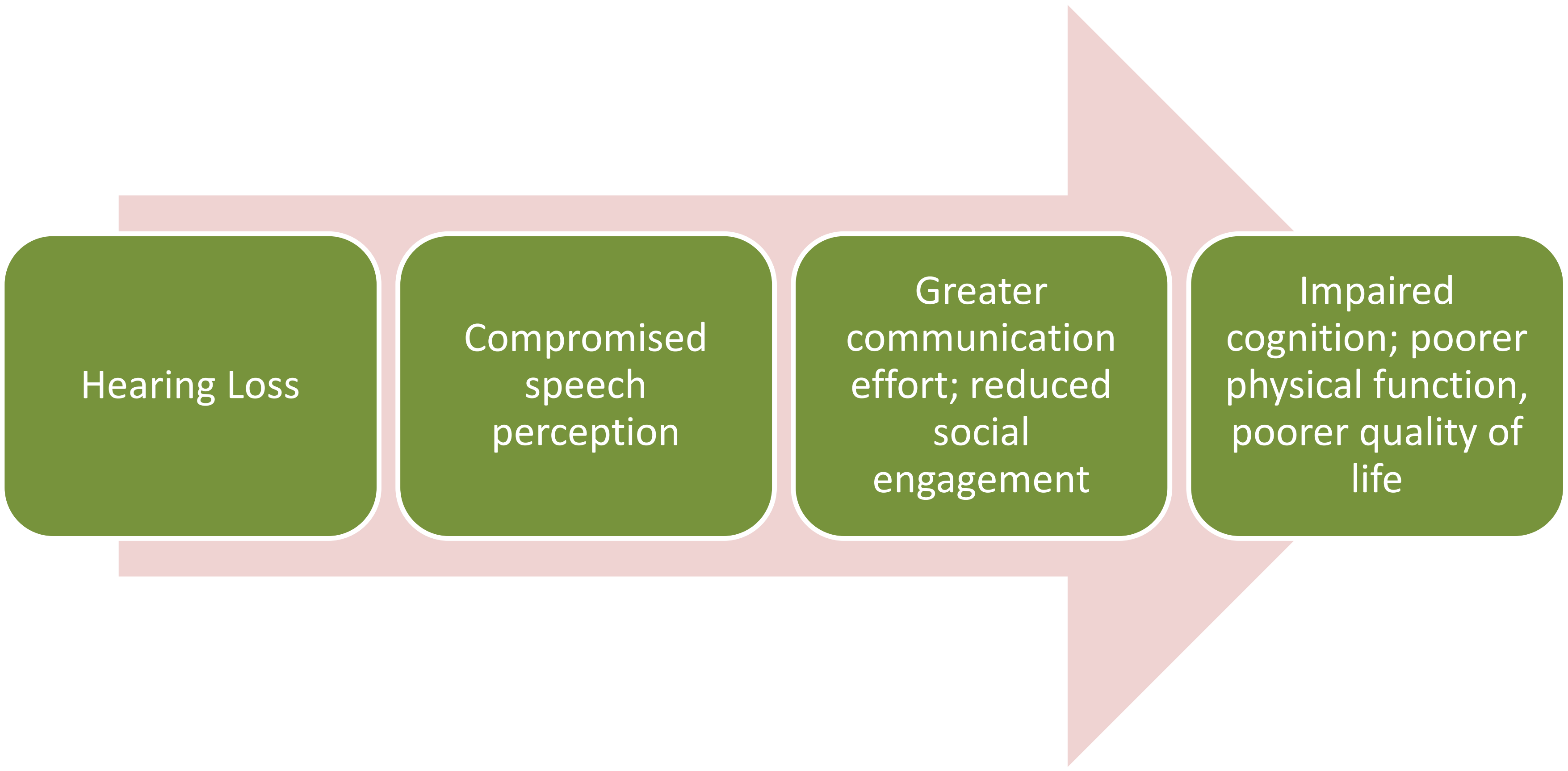
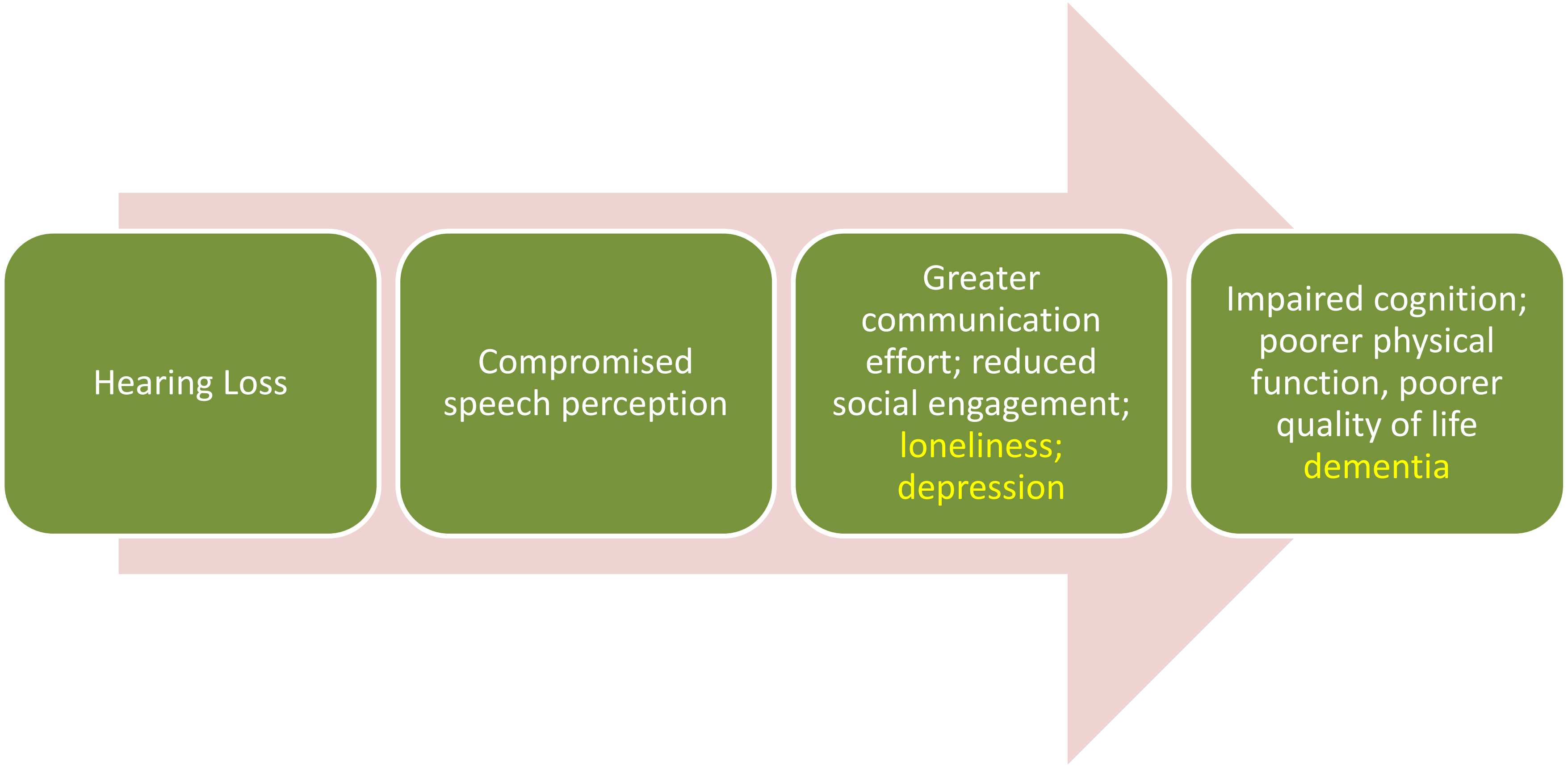


Figure 1. A, The overall acoustic challenge experienced by a given listener is a combination of individual hearing ability and external acoustic characteristics (including speech quality and background noise). (Note only a subset of these conditions are directly addressed in the main text.) Acoustic challenge increases cognitive demand, which is a key contributor to listening effort (moderated by motivation). When speech is not easily matched to a listener's expectation, additional neural processing is frequently required. B, Increases in listening effort can be observed through functional brain imaging, are reflected in physiological responses outside the brain, and frequently result in measurable differences in behavior.


Hearing Loss
Compromised speech perception
Greater communication effort; reduced social engagement
Impaired cognition; poorer physical function, poorer quality of life


Hearing Loss
Compromised speech perception
Greater communication effort; reduced social engagement; loneliness; depression
Impaired cognition; poorer physical function, poorer quality of life dementia

MORTALITY

Age and Ageing Advance Access published August 30, 2013

Age and Ageing 2013; 0: 1–7
doi: 10.1093/ageing/aft122

Impairments in hearing and vision impact on mortality in older people: the AGES-Reykjavik Study

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Abstract

Objective: to examine the relationships between impairments in hearing and vision and mortality from all-causes and cardiovascular disease (CVD) among older people.
Design: population-based cohort study.
Participants: the study population included 4,926 Icelandic individuals, aged ≥67 years, 43.4% male, who completed vision and hearing examinations between 2002 and 2006 in the Age, Gene/Environment Susceptibility-Reykjavik Study (AGES-RS) and were followed prospectively for mortality through 2009.
Methods: participants were classified as having 'moderate or greater' degree of impairment for vision only (VI), hearing only (HI), and both vision and hearing (dual sensory impairment, DSI). Cox proportional hazard regression, with age as the time scale, was used to calculate hazard ratios (HR) associated with impairment and mortality due to all-causes and specifically CVD after a median follow-up of 5.3 years.
Results: the prevalence of HI, VI and DSI were 25.4, 9.2 and 7.0%, respectively. After adjusting for age, significantly ($P < 0.01$) increased mortality from all causes, and CVD was observed for HI and DSI, especially among men. After further adjustment for established mortality risk factors, people with HI remained at higher risk for CVD mortality [HR: 1.70 (1.27–2.27)], whereas people with DSI remained at higher risk of all-cause mortality [HR: 1.43 (1.11–1.85)] and CVD mortality [HR: 1.78 (1.18–2.69)]. Mortality rates were significantly higher in men with HI and DSI and were elevated, although not significantly, among women with HI.
Conclusions: older men with HI or DSI had a greater risk of dying from any cause and particularly cardiovascular causes within a median 5-year follow-up. Women with hearing impairment had a non-significantly elevated risk. Vision impairment alone was not associated with increased mortality.

Keywords: *AGES-Reykjavik study, hearing, vision, dual sensory impairment, all-cause mortality, cardiovascular disease mortality, older people*

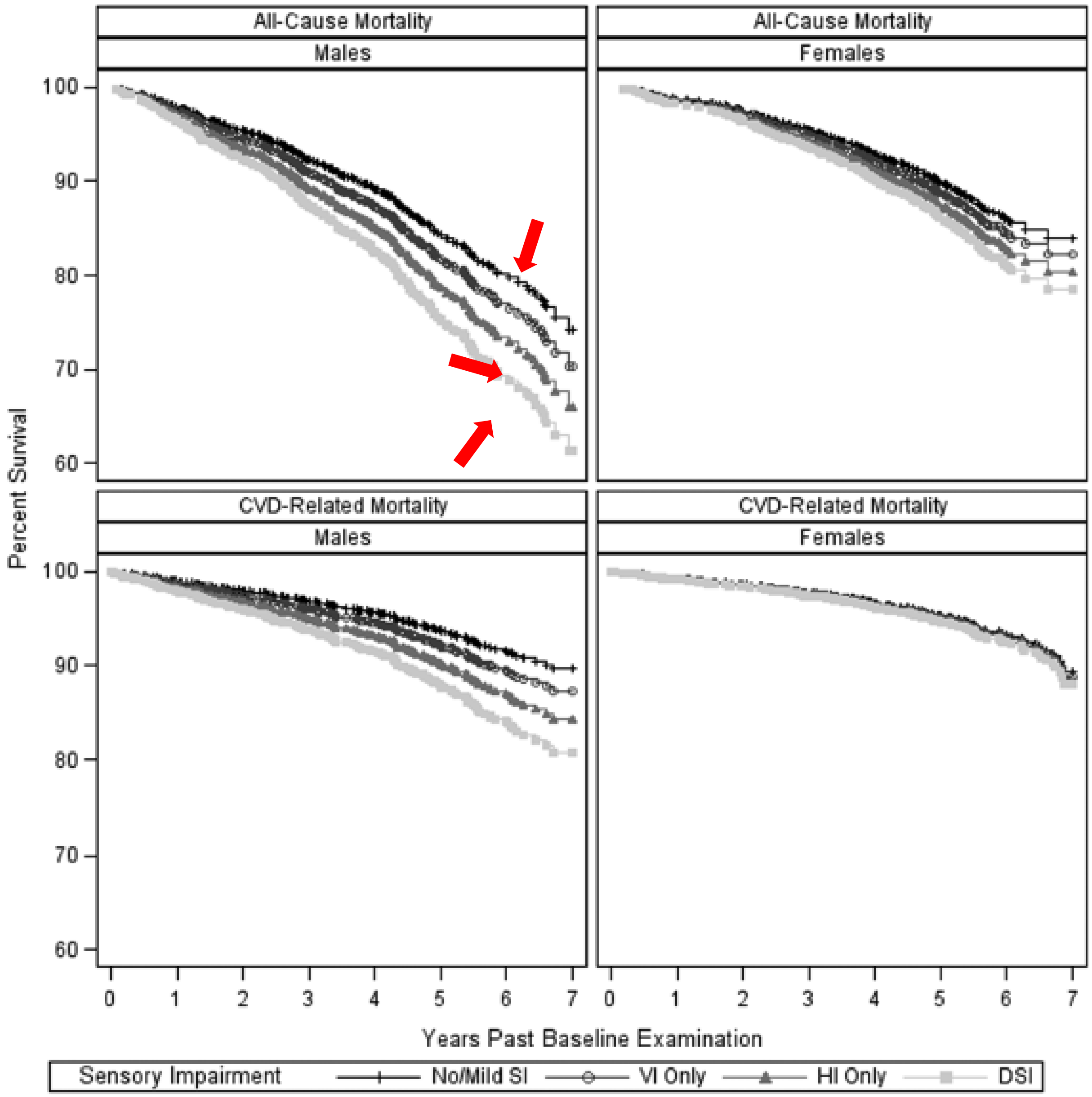

Figure 1. Kaplan–Meier plots for all-cause and CVD-related mortality rates by type of sensory impairment, stratified by sex and adjusted for age.

EFFECTS OF AMPLIFICATION

Hearing Aids & Falls

The Laryngoscope

The Effect of Hearing Aids on Postural Stability

Kavelin Rumalla; Adham M. Karim, BS; Timothy E. Hullar, MD

Objectives/Hypothesis: In the United States, falls are the leading cause of accidental deaths in adults aged over 65 years. Epidemiologic studies indicate that there is a correlation between hearing loss and the risk of falling among older people. The vestibular, proprioceptive, and visual systems are known to contribute to postural stability, but the contribution of audition to maintaining balance has not yet been determined.

Study Design: Cross-sectional study to measure postural stability in bilateral hearing-aid users aged over 65 years in aided and unaided conditions.

Methods: Balance was assessed using the Romberg on foam test and the tandem stance test. Tests were administered in the presence of a point-source broadband white-noise sound (0–4 kHz) source in both unaided and aided conditions in the dark. Subjective measures of balance were made using the Activities-specific Balance Confidence Scale.

Results: Performance was significantly better in the aided than the unaided condition ($P = 0.005$ for both tests). No statistically significant relationship between improvement in balance, and hearing was identified. Participants did not report that they perceived a difference in balance between the two conditions.

Conclusion: These results indicate that hearing aids are a novel treatment modality for imbalance in older adults with hearing loss and suggest that wearing hearing aids may offer a significant public-health benefit for avoiding falls in this population.

Key Words: Fall, elderly, hearing, aid, audition, Romberg, auditory, landmark, posture, stability, balance.

Level of Evidence: 4.

***Laryngoscope*, 125:720–723, 2015**

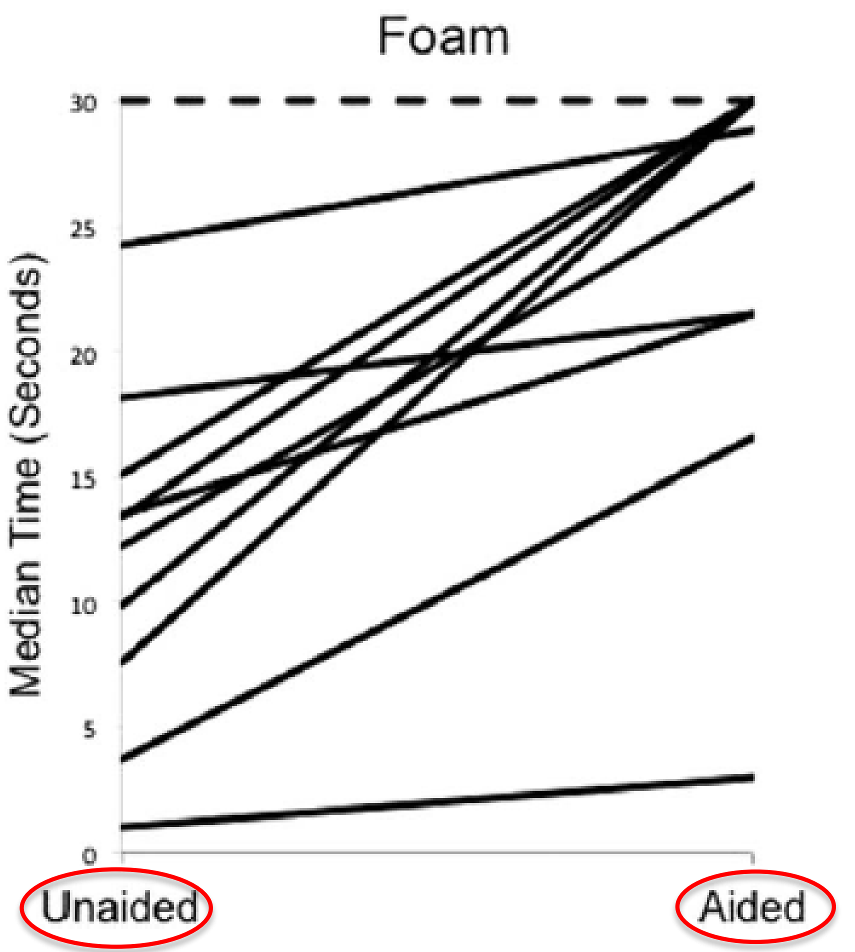

Fig. 1. Effect of wearing hearing aids when performing the Romberg on foam test. Length of time over which 14 participants could stand in unaided and aided conditions (maximum of 30 seconds). Dashed line represents the four participants who scored perfectly on the test.

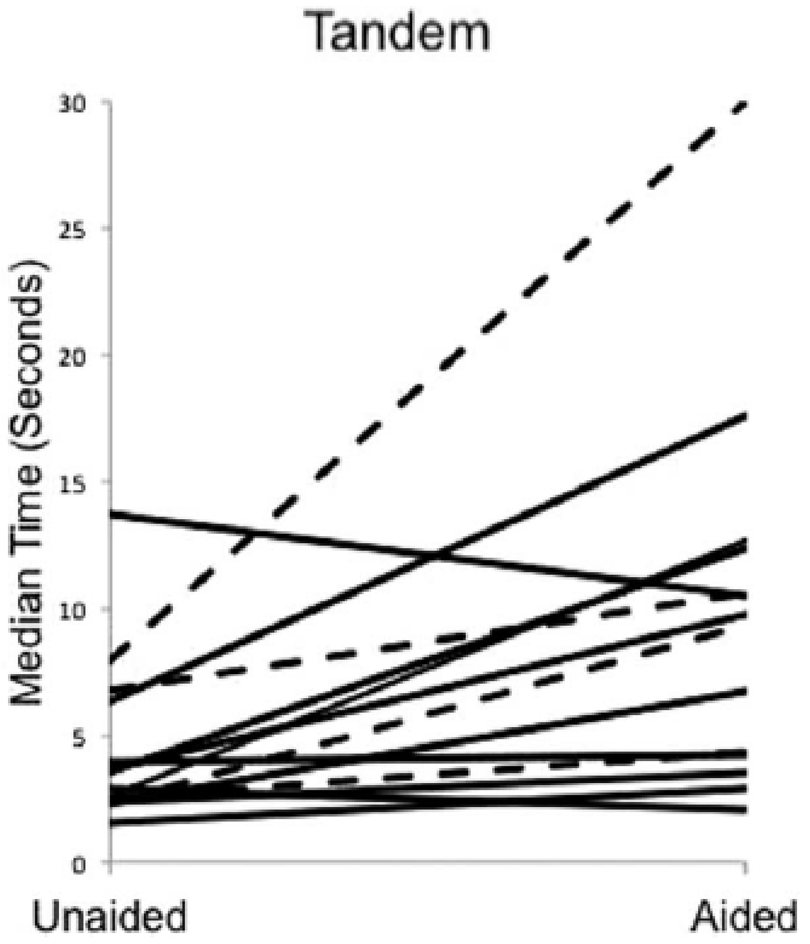

Fig. 2. Effect of wearing hearing aids when performing the tandem stance test. Length of time over which participants could stand during unaided and aided conditions (maximum of 30 seconds). Dashed lines correspond to the four participants who scored perfectly on the Romberg on foam test.

- Mechanism of the improvement is the presence of an artificial point sound source that resulted from wearing hearing aids
  - Acts as effective spatial orienting landmarks, just as visible objects serve as landmarks to improve stability with sight
- The brain relies on the sound localization ability of the ears to create a three-dimensional map of the sound sources around an individual and keeps the body steady by maintaining its relationship to these external landmarks constant

Hearing Aids & Depression

Table 2. Stepwise Logistic Regression Models of the Odds of Major Depressive Disorder or Any Depressive Symptoms per 25 dB of Hearing Loss (HL) and Hearing Aid Use (HA)

	Major Depressive Disorder		Any Depressive Symptoms	
	BPTA per 25-dB HL	HA	BPTA per 25-dB HL	HA
Model	Odds Ratio (95% Confidence Interval)			
Base (HL + HA)	1.50 (0.74–3.04)	0.28 (0.13–0.60)[a]	1.63 (0.90–2.97)	0.27 (0.12–0.59)[a]
Base plus demographic factors	1.59 (0.63–4.03)	0.34 (0.14–0.83)[b]	1.54 (0.76–3.14)	0.34 (0.15–0.79)[b]
Base plus demographic and cardiovascular factors	1.63 (0.66–4.02)	0.35 (0.14–0.90)[b]	1.58 (0.77–3.25)	0.33 (0.14–0.77)[b]

BPTA=better ear pure tone average (per 25-dB loss). Hearing loss is defined as a speech-frequency pure tone average of hearing thresholds at 0.5, 1, 2, and 4 kHz in the better-hearing ear. Demographic factors include age, sex, race and ethnicity, and education; cardiovascular risk factors include hypertension, diabetes mellitus, smoking status, and stroke.

[a] $P < .001$.

[b] $P < .05$.

Mener DJ, Betz J, Genther DJ, Chen D, Lin FR. (2013) Hearing loss and depression in older adults. J Am Geriatr Soc 61(9):1627–29

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journal homepage: www.elsevier.com/locate/archger

Effects of hearing aids on cognitive functions and depressive signs in elderly people

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Treatment of presbycusis
Psychocognitive functions
Mini mental state examination (MMSE)
Geriatric depression scale (GDS)

ABSTRACT

With the physical, emotional and cognitive effects of senility, elderly people, especially those with impaired hearing, need rehabilitation for improving their life conditions. Hearing aids are frequently used to improve their daily life communications and activities. The aim of this study was to report the cognitive and psychological benefits of using hearing aids by the elderly people, over the age of 65. This was a prospective, single-arm interventional study in 34 elderly subjects with hearing impairment who answered the geriatric depression scale-short form (GDS) questionnaire and the mini mental state examination (MMSE) test, prior to, and 3 months following the use of hearing aid, after obtaining the patients' consent to participate in study. Patients with evidence of focal neurological loss with clinical examination, a confusional state, sudden hear loss and severe tinnitus were not included in the study. Scores of the effects of hearing aids on mood and cognitive functions were compared for each subject, before and after, and between males and females. After 3 months of using a hearing aid, all patients showed a significant improvement of the psychosocial and cognitive conditions, and all of them showed betterment of their problems, i.e., the social communication and exchanging information. In conclusion, for the elderly people with the effects of hearing aids in presbycusis and due to the significant improvement in psychological state and mental functions, using and being adaptable to hearing aids is a good solution.

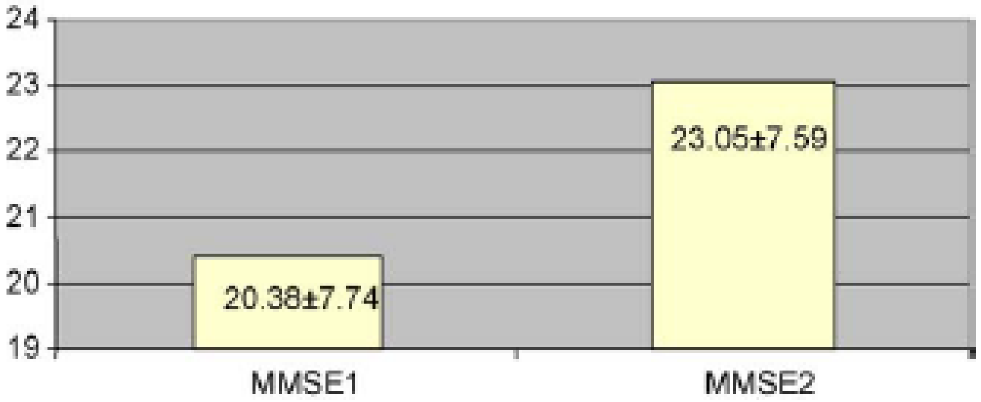

Fig. 1. Comparison of the mean MMSE scores in patients before (1) and after (2) hearing improvement ($p < 0.005$).

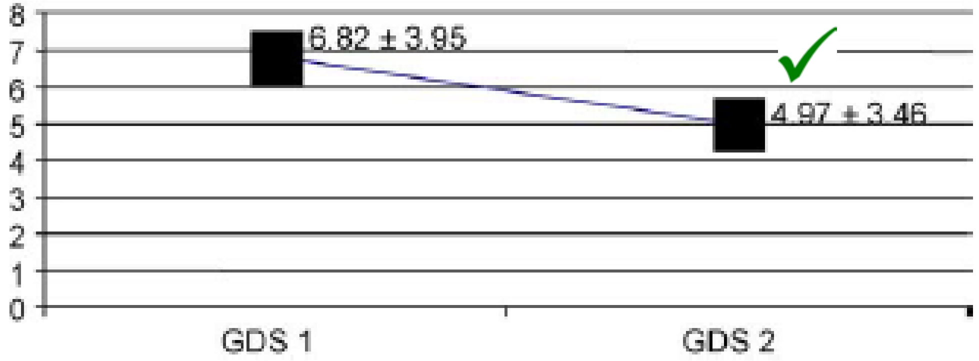

Fig. 2. The mean GDS scores in patients before (1) and after (2) the hearing improvement ($p < 0.005$).

*Geriatr Gerontol Int 2012; **12**: 440–445*

ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Hearing loss and depressive symptoms in elderly patients

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[1]*Department of Internal Medicine and Medical Specialties, Section of Geriatrics, University of Genova,* [2]*Linear Hearing Aids, and* [3]*Department Head and Neck, Section of Otorhinolaringology, University-Hospital San Martino, Genova, Italy*

Aims: Hearing loss is a common disability that has a profound impact on communication and daily functioning in the elderly. The present study assesses the effects of hearing aids on mood, quality of life and caregiver burden when hearing loss, comorbidity and depressive symptoms coexist in the elderly.

Methods: A total of 15 patients aged older than 70 years suffering from hearing loss and depressive mood were recruited. Comorbidity was evaluated by the Cumulative Illness Rating Scale, functional ability by the Activities of Daily Living scale and the Lawton Instrumental Activities of Daily Living scale, cognitive capacity by the Mini-mental State Examination and the Clock Drawing Test, psychological status by the Center for Epidemiological Studies-Depression scale, and quality of life by the Short Form (36) Health Survey. Caregiver burden was appraised by the Caregiver Burden Inventory. Testing was carried out at baseline and at 1-, 3- and 6-month intervals, assessing the use of binaural digital and programmable hearing aids.

Results: Reduction in depressive symptoms and improved quality of life at statistically significant levels were observed early on with the use of hearing aids. In particular, general health ($P < 0.02$), vitality ($P < 0.03$), social functioning ($P < 0.05$), emotional stability ($P < 0.05$) and mental health ($P < 0.03$) all changed for the better, and were maintained for the study duration. The degree of caregiver burden also declined, remaining low throughout the study.

Conclusions: The benefits of digital hearing aids in relation to depressive symptoms, general health and social interactivity, but also in the caregiver – patient relationship, were clearly shown in the study. The elderly without cognitive decline and no substantial functional deficits should be encouraged to use hearing aids to improve their quality of life. **Geriatr Gerontol Int 2012; 12: 440–445.**

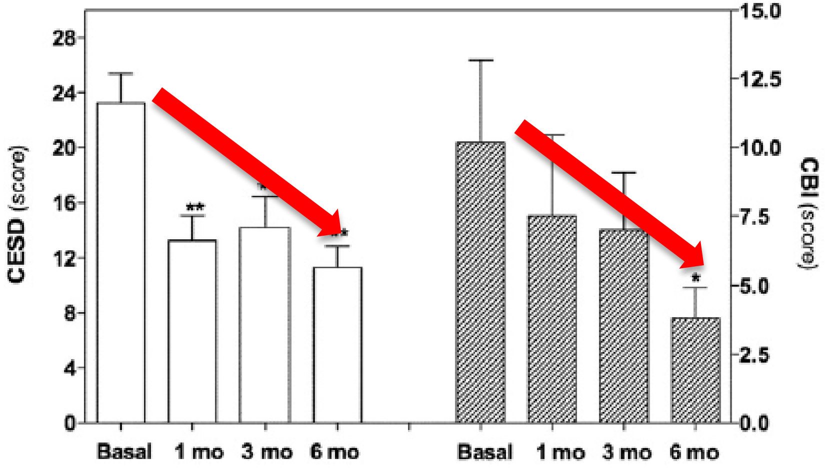


Figure 1 Center for Epidemiological Studies-Depression Scale (CES-D) and Caregiver Burden Inventory (CBI) scoring. Changes during 6-month observation of CES-D and CBI score. $^*P < 0.05$; $^{**}P < 0.01$ versus basal. Mo, Months.

Figure 2 Health Survey Short-Form (SF-36) questionnaire scoring. The change during 6-months observation of single items general health, vitality, social functioning, role-emotional, mental health, respective changes in physical functioning, role- physical and bodily pain item (---- baseline; --- 1 month; -- 3 months; — 6 months).

Hearing Aids and Loneliness

AJA

Research Article

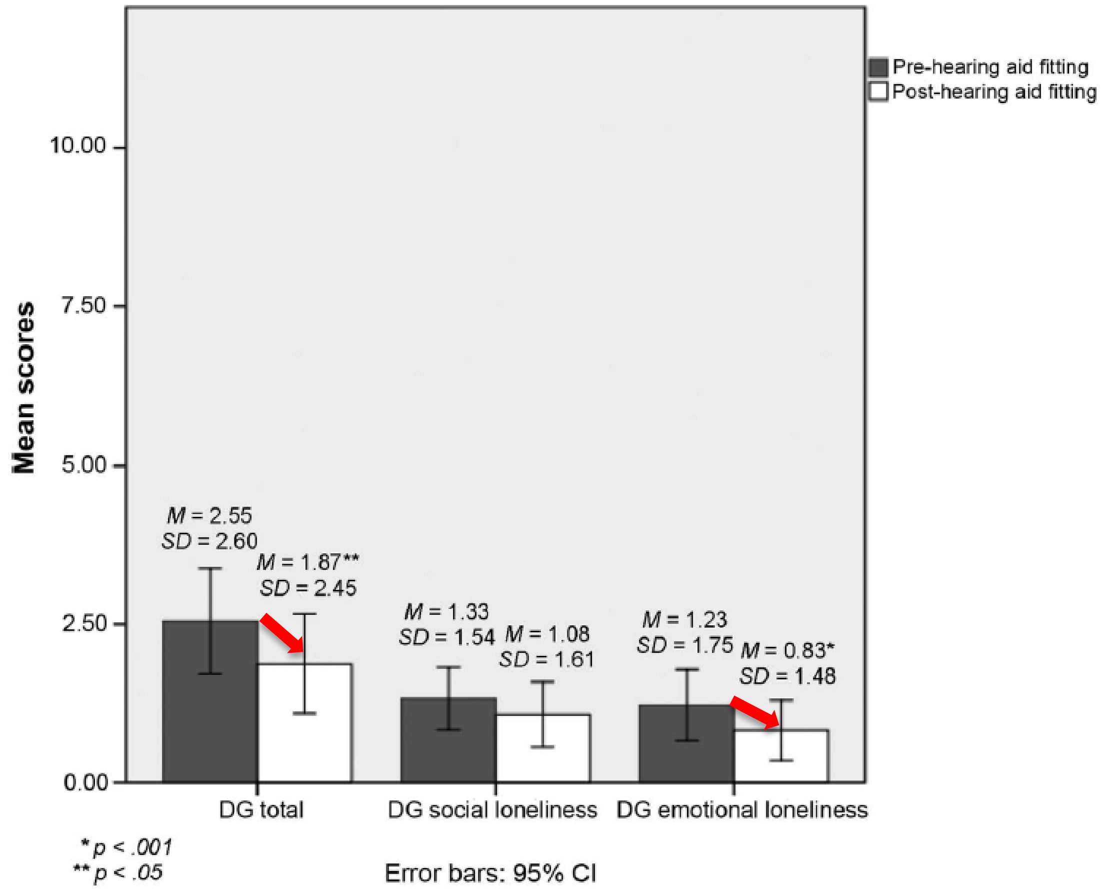
Relating Hearing Aid Use to Social and Emotional Loneliness in Older Adults

Barbara E. Weinstein,[a] Lynn W. Sirow,[b] and Sarah Moser[c]

Purpose: Hearing loss is a risk factor for social isolation and loneliness. We investigated the buffering effects of hearing aid use on perceived social and emotional loneliness.
Method: Forty older adults participated. Prior to and following the hearing aid fitting, participants completed the De Jong Gierveld Loneliness Scale (De Jong Gierveld & Kamphuis, 1985); a change in feelings of loneliness following hearing aid use was the outcome indicator.
Results: There was a significant decline in perceptions of loneliness following 4 to 6 weeks of hearing aid use. A dose effect emerged with persons with moderate-to-severe hearing loss experiencing the greatest reduction in perceived loneliness with hearing aid use.
Conclusion: Associated with poorer health status and higher consumption of health care services, perceived loneliness is a challenge to treat. Hearing aid use appears to be a buffer against the experience of loneliness.

Weinstein et al. *Amer J Audiol* 2016;25:54

Figure 2. Change in score on De Jong Gierveld Loneliness Scale following 4 to 6 weeks of hearing aid use. *Note*. M = mean; SD = standard deviation; CI = confidence interval.



Liljas, et al. (2016)

SENSORY IMPAIRMENTS AND CARDIOVASCULAR DISEASE INCIDENCE AND MORTALITY IN OLDER BRITISH COMMUNITY-DWELLING MEN: A 10-YEAR FOLLOW-UP STUDY

Hearing Aids & CVD

JAGS FEBRUARY 2016–VOL. 64, NO. 2 LETTERS TO THE EDITOR 443

Table 1. Risk of Outcome According to Sensory Impairment in Men Aged 63 to 85 in 2003 from the British Regional Heart Study

	Incident CVD		Incident Myocardial Infarction		Incident Stroke		CVD Mortality	
Sensory Impairment	Rate/ 1,000 (n)	HR (95% CI)	Rate/ 1,000 (n)	HR (95% CI)	Rate/ 1,000 (n)	HR (95% CI)	Rate/ 1,000 (n)	HR (95% CI)
Hearing								
Could hear	17 (330)	1.00	9 (191)	1.00	7 (149)	1.00	10 (257)	1.00
Could hear, used aid	20 (59)	0.91 (0.68–1.20)	13 (40)	1.09 (0.77–1.55)	7 (23)	0.76 (0.49–1.19)	17 (68)	1.15 (0.88–1.51)
Could not hear, no aid	25 (69)	1.42 (1.09–1.84)[a]	13 (38)	1.35 (0.95–1.91)	11 (32)	1.46 (1.00–2.14)[a]	15 (52)	1.37 (1.02–1.85)[a]
Could not hear, used aid	22 (22)	1.10 (0.71–1.70)	14 (14)	1.26 (0.73–2.17)	8 (8)	0.88 (0.43–1.80)	15 (20)	1.11 (0.71–1.76)
Vision								
Could see	18 (467)	1.00	10 (273)	1.00	8 (209)	1.00	12 (383)	1.00
Poor vision	24 (16)	1.20 (0.73–1.97)	16 (11)	1.41 (0.77–2.57)	7 (5)	0.85 (0.35–2.06)	19 (17)	1.42 (0.87–2.30)
Dual								
Could hear and could see	17 (326)	1.00	9 (185)	1.00	8 (151)	1.00	10 (254)	1.00
Dual impairment	26 (8)	1.40 (0.69–2.83)	13 (4)	1.23 (0.46–3.31)	13 (4)	1.52 (0.56–4.12)	22 (9)	1.73 (0.89–3.36)

[a]Remained statistically significant after further adjustment for social class, obesity, smoking, physical activity, hypertension, and diabetes mellitus.
CVD = cardiovascular disease; HR = hazard ratio; CI = confidence interval.

Hearing Aids & Cognition

Self-Reported Hearing Loss, Hearing Aids, and Cognitive Decline in Elderly Adults: A 25-Year Study

Hélène Amieva, PhD, Camille Ouvrard, MSc, Caroline Giulioli, MSc, Céline Meillon, MSc, Laetitia Rullier, PhD, and Jean-François Dartigues, MD, PhD

OBJECTIVES: To investigate the association between hearing loss, hearing aid use, and cognitive decline.

DESIGN: Prospective population-based study.

SETTING: Data gathered from the Personnes Agées QUID study, a cohort study begun in 1989–90.

PARTICIPANTS: Individuals aged 65 and older (N = 3,670).

MEASUREMENTS: At baseline, hearing loss was determined using a questionnaire assessing self-perceived hearing loss; 137 subjects reported major hearing loss, 1,139 reported moderate problems (difficulty following the conversation when several persons talk at the same time or in a noisy background), and 2,394 reported no hearing trouble. Cognitive decline was measured using the Mini-Mental State Examination (MMSE), administered at follow-up visits over 25 years.

RESULTS: Self-reported hearing loss was significantly associated with lower baseline MMSE score ($\beta = -0.69$, $P < .001$) and greater decline during the 25-year follow-up period ($\beta = -0.04$, $P = .01$) independent of age, sex, and education. A difference in the rate of change in MMSE score over the 25-year follow-up was observed between participants with hearing loss not using hearing aids and controls ($\beta = -0.06$, $P < .001$). In contrast, subjects with hearing loss using a hearing aid had no difference in cognitive decline ($\beta = 0.07$, $P = .08$) from controls.

CONCLUSION: Self-reported hearing loss is associated with accelerated cognitive decline in older adults; hearing aid use attenuates such decline. J Am Geriatr Soc 63:2099–2104, 2015.

Key words: hearing loss; hearing aids; cognitive decline; elderly

Hearing loss is the third most common chronic health condition affecting older adults. Approximately 30% of individuals aged 65 and older have some degree of hearing loss, with estimates ranging from 70% to 90% of those aged 85 and older.[1,2] Individuals with hearing loss often experience depressive symptoms and social isolation.[3–7] There is also evidence that older adults with hearing loss have poorer cognitive performance.[8–13] Two longitudinal studies showed an association between hearing loss and cognitive decline over 6 years of follow-up.[14,15] In particular, the Health, Aging and Body Composition (Health ABC) Study, conducted in a sample of 1,984 community-dwelling individuals aged 70 to 79 showed that hearing loss measured using audiometric testing was independently associated with accelerated cognitive decline and incident cognitive impairment during the 6 years of follow-up.[15]

Despite its high prevalence and consequences for health outcomes, hearing loss is largely underdiagnosed and thus undertreated.[16] Almost two-thirds of older adults with hearing impairment do not use hearing aids.[17] Little is known about the effect of hearing aids on health outcomes in older adults, in particular cognitive decline. In one study,[15] hearing aid use was associated with slightly lower rates of cognitive decline and risk of incident cognitive impairment in individuals with hearing loss, but the results were not statistically significant, possibly because of the short follow-up and lack of statistical power. In the other longitudinal study,[14] because of small sample size, the association between hearing aid use and cognitive decline could not be properly examined.

- After adjusting for the age, sex, and educational levels, the authors reported that non-users had a higher cognitive decline rate than those with normal hearing (~1.5 points over the 25-year period) but hearing aid users did not
- **When all other factors were adjusted, however, there was no difference among the two groups of participants with hearing loss**
- The authors concluded that hearing aids did not slow down cognitive decline, but they reduced the negative effects of hearing loss on participants' psychosocial behaviors

PLOS | ONE

RESEARCH ARTICLE

Hearing Loss and Cognition: The Role of Hearing Aids, Social Isolation and Depression

Piers Dawes[1]*, Richard Emsley[2], Karen J. Cruickshanks[3], David R. Moore[4,5,6], Heather Fortnum[5,7], Mark Edmondson-Jones[5,7], Abby McCormack[5,6,7], Kevin J. Munro[1,8]

1 School of Psychological Sciences, University of Manchester, Manchester, United Kingdom, **2** Centre for Biostatistics, Institute of Population Health, University of Manchester, Manchester, United Kingdom, **3** Population Health Sciences and Ophthalmology and Visual Sciences, School of Medicine and Public Health, University of Wisconsin, Madison, Wisconsin, United States of America, **4** Cincinnati Children's Hospital Medical Center and Department of Otolaryngology, University of Cincinnati College of Medicine, Cincinnati, Ohio, United States of America, **5** NIHR Nottingham Hearing Biomedical Research Unit, Nottingham, United Kingdom, **6** MRC Institute of Hearing Research, Nottingham, United Kingdom, **7** Otology and Hearing Group, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham, United Kingdom, **8** Central Manchester Universities Hospitals NHS Foundation Trust, Manchester, United Kingdom

* piers.dawes@manchester.ac.uk

Citation: Dawes P, Emsley R, Cruickshanks KJ, Moore DR, Fortnum H, Edmondson-Jones M, et al. (2015) Hearing Loss and Cognition: The Role of Hearing Aids, Social Isolation and Depression. PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

Academic Editor: Blake Johnson, ARC Centre of Excellence in Cognition and its Disorders (CCD), AUSTRALIA

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Abstract

Hearing loss is associated with poor cognitive performance and incident dementia and may contribute to cognitive decline. Treating hearing loss with hearing aids may ameliorate cognitive decline. The purpose of this study was to test whether use of hearing aids was associated with better cognitive performance, and if this relationship was mediated via social isolation and/or depression. Structural equation modelling of associations between hearing loss, cognitive performance, social isolation, depression and hearing aid use was carried out with a subsample of the UK Biobank data set (n = 164,770) of UK adults aged 40 to 69 years who completed a hearing test. Age, sex, general health and socioeconomic status were controlled for as potential confounders. Hearing aid use was associated with better cognition, independently of social isolation and depression. This finding was consistent with the hypothesis that hearing aids may improve cognitive performance, although if hearing aids do have a positive effect on cognition it is not likely to be via reduction of the adverse effects of hearing loss on social isolation or depression. We suggest that any positive effects of hearing aid use on cognition may be via improvement in audibility or associated increases in self-efficacy. Alternatively, positive associations between hearing aid use and cognition may be accounted for by more cognitively able people seeking and using hearing aids. Further research is required to determine the direction of association, if there is any direct causal relationship between hearing aid use and better cognition, and whether hearing aid use results in reduction in rates of cognitive decline measured longitudinally.

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Effects of hearing aids on cognitive functions and depressive signs in elderly people

Baran Acar *, Muge Fethiye Yurekli, Mehmet Ali Babademez, Hayriye Karabulut, Rıza Murat Karasen

Kecioren Training and Research Hospital, Department of Otorhinolaryngology, Pinarbasi Mahallesi Sanatoryum Caddesi Ardahan Sok. No: 1, Kecioren 06310, Ankara, Turkey

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Psychocognitive functions
Mini mental state examination (MMSE)
Geriatric depression scale (GDS)

ABSTRACT

With the physical, emotional and cognitive effects of senility, elderly people, especially those with impaired hearing, need rehabilitation for improving their life conditions. Hearing aids are frequently used to improve their daily life communications and activities. The aim of this study was to report the cognitive and psychological benefits of using hearing aids by the elderly people, over the age of 65. This was a prospective, single-arm interventional study in 34 elderly subjects with hearing impairment who answered the geriatric depression scale-short form (GDS) questionnaire and the mini mental state examination (MMSE) test, prior to, and 3 months following the use of hearing aid, after obtaining the patients' consent to participate in study. Patients with evidence of focal neurological loss with clinical examination, a confusional state, sudden hear loss and severe tinnitus were not included in the study. Scores of the effects of hearing aids on mood and cognitive functions were compared for each subject, before and after, and between males and females. After 3 months of using a hearing aid, all patients showed a significant improvement of the psychosocial and cognitive conditions, and all of them showed betterment of their problems, i.e., the social communication and exchanging information. In conclusion, for the elderly people with the effects of hearing aids in presbycusis and due to the significant improvement in psychological state and mental functions, using and being adaptable to hearing aids is a good solution.

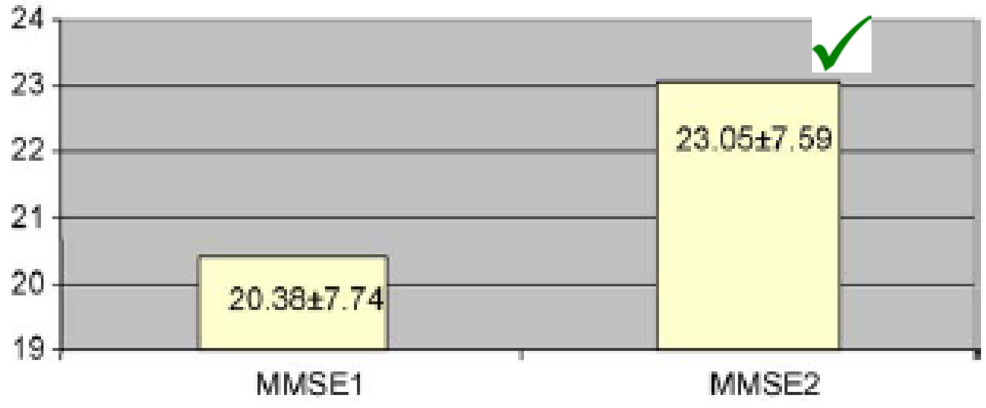


Fig. 1. Comparison of the mean MMSE scores in patients before (1) and after (2) hearing improvement ($p < 0.005$).

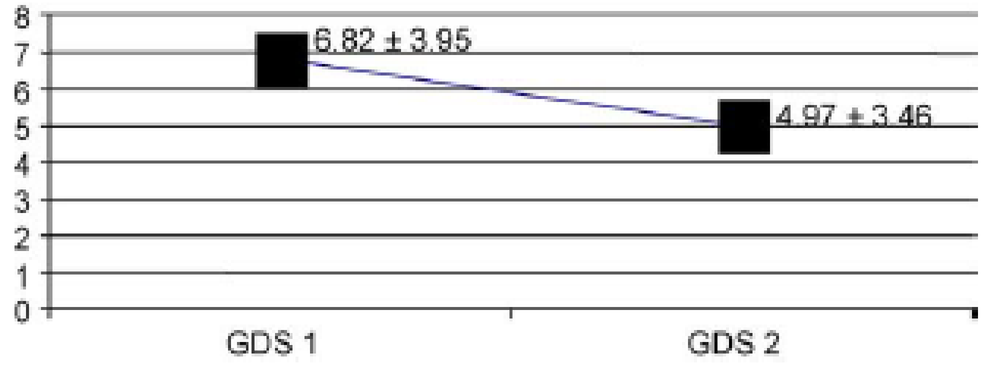
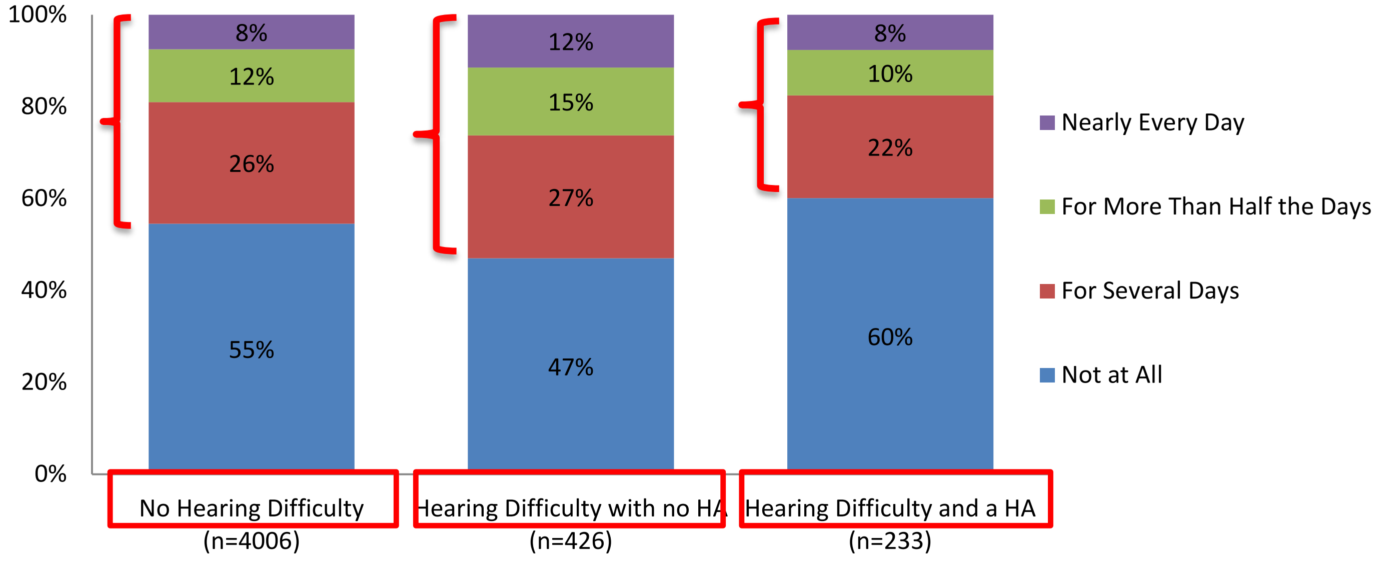


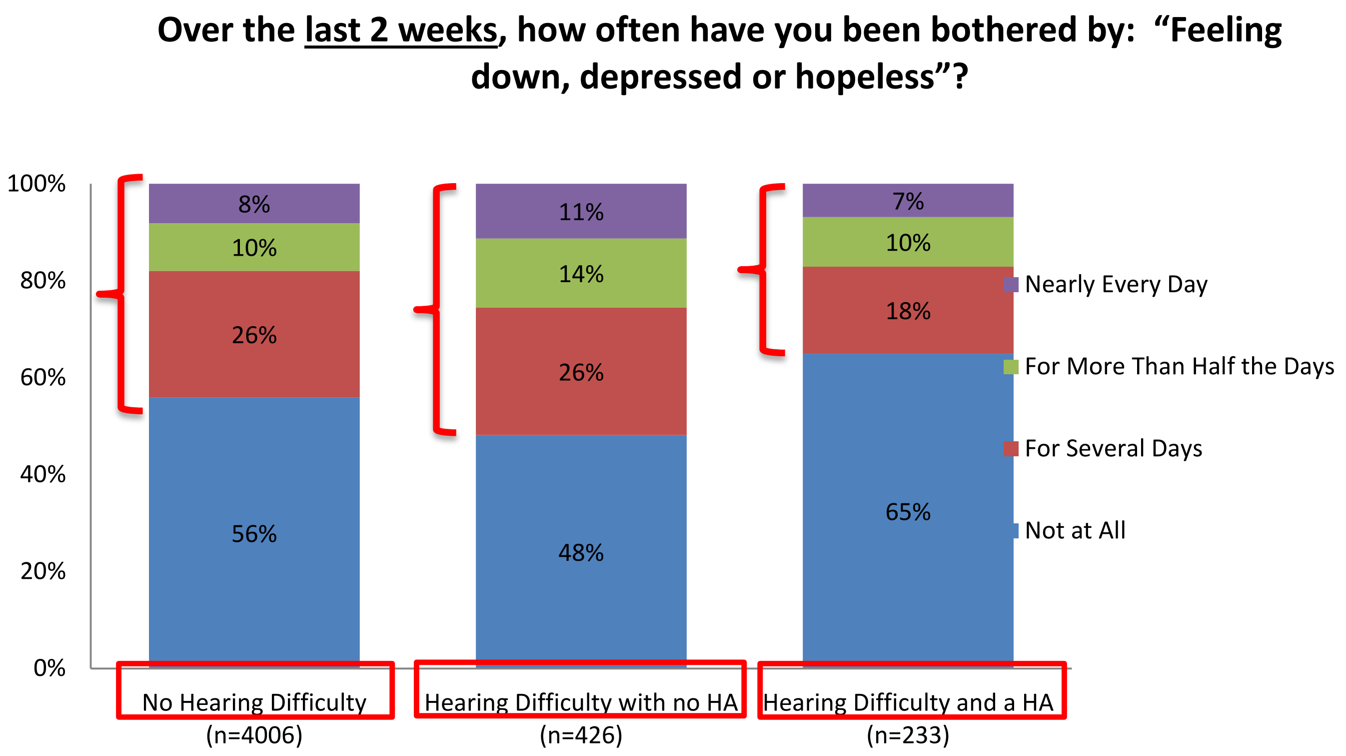
Fig. 2. The mean GDS scores in patients before (1) and after (2) the hearing improvement ($p < 0.005$).

MarkeTrak 9
Lack of Interest or Pleasure

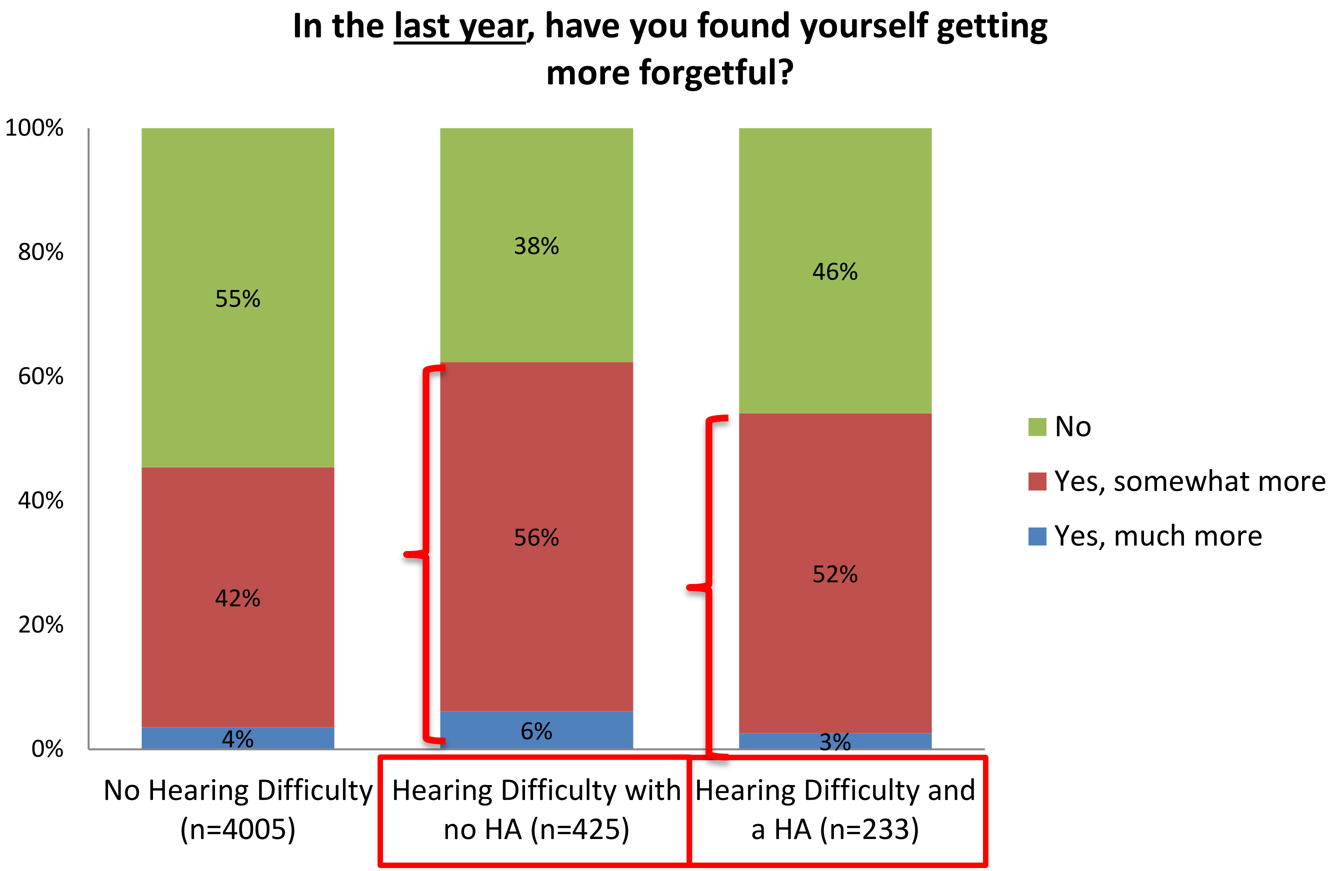
Over the last 2 weeks, how often have you been bothered by: "Little interest or pleasure in doing things?"



MarkeTrak 9
Depression



MarkeTrak 9
Forgetfulness



An incorrect version of this article appeared in *Trends in Amplification*, 12(2), 85-102.
Original DOI: 10.1177/1084713808316173. This is a corrected reprint of the original article.

Trends in Amplification
Volume 12 Number 3
September 2008 254-271

10.1177/1084713808323483
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http://online.sagepub.com

Reorganization of the Adult Auditory System: Perceptual and Physiological Evidence From Monaural Fitting of Hearing Aids

Kevin J. Munro, PhD

Changes in the sensory environment modify our sensory experience and may result in experience-related or learning-induced reorganization within the central nervous system. Hearing aids change the sensory environment by stimulating a deprived auditory system; therefore, they may be capable of inducing changes within the central auditory system. Examples of studies that have shown hearing aid induced perceptual and/or physiological changes in the adult human auditory system are discussed. Evidence in the perceptual domain is provided by studies that have investigated (a) speech perception, (b) intensity discrimination, and (c) loudness perception. Evidence in the physiological domain is provided by studies that have investigated acoustic reflex thresholds and event-related potentials. Despite the controversy in the literature concerning the rate, extent, and clinical significance of the acclimatization effect, there is irrefutable evidence that the deprived auditory system of some listeners can be modified with hearing aid experience.

Keywords: reorganization; plasticity; hearing aids; acclimatization; auditory deprivation

Munro K. (2008). Reorganization of the Adult Auditory System: Perceptual and Physiological Evidence from Monaural Fitting of Hearing Aids. *Trends Hear*, *12*(3):254-271. doi:10.1177/1084713808323483

JSLHR

Research Article

Hearing Aid–Induced Plasticity in the Auditory System of Older Adults: Evidence From Speech Perception

Limor Lavie,[a] Karen Banai,[a] Avi Karni,[a] and Joseph Attias[a]

Purpose: We tested whether using hearing aids can improve unaided performance in speech perception tasks in older adults with hearing impairment.
Method: Unaided performance was evaluated in dichotic listening and speech-in-noise tests in 47 older adults with hearing impairment; 36 participants in 3 study groups were tested before hearing aid fitting and after 4, 8, and 14 weeks of hearing-aid use. The remaining 11 participants served as a control group and were similarly evaluated but were not fitted with hearing aids. Three protocols were compared in the study groups: amplification for the nondominant ear, amplification for the dominant ear, and bilateral amplification. Subsequently, after 4 weeks, all participants were afforded bilateral amplification.

Results: In the study groups, unaided dichotic listening scores improved significantly in the nondominant ear by 8 weeks and onward. Significant improvements were also observed for unaided speech identification in noise, with some gains apparent after 4 weeks of hearing-aid use. No gains were observed in the control group.
Conclusions: Using hearing aids for a relatively short period can induce changes in the way older adults process auditory inputs in perceptual tasks such as speech identification in noise and dichotic listening. These changes suggest that the central auditory system of older adults retains the potential for behaviorally relevant plasticity.

Lavie L, Banai K, Karni A, Attias J. (2015). Hearing aid-induced plasticity in the auditory system of older adults: Evidence from speech perception. *JSLHR, 58*:1601-1610. doi:10.1044/2015_JSLHR-H-14-0225

Dementia & Hearing Loss

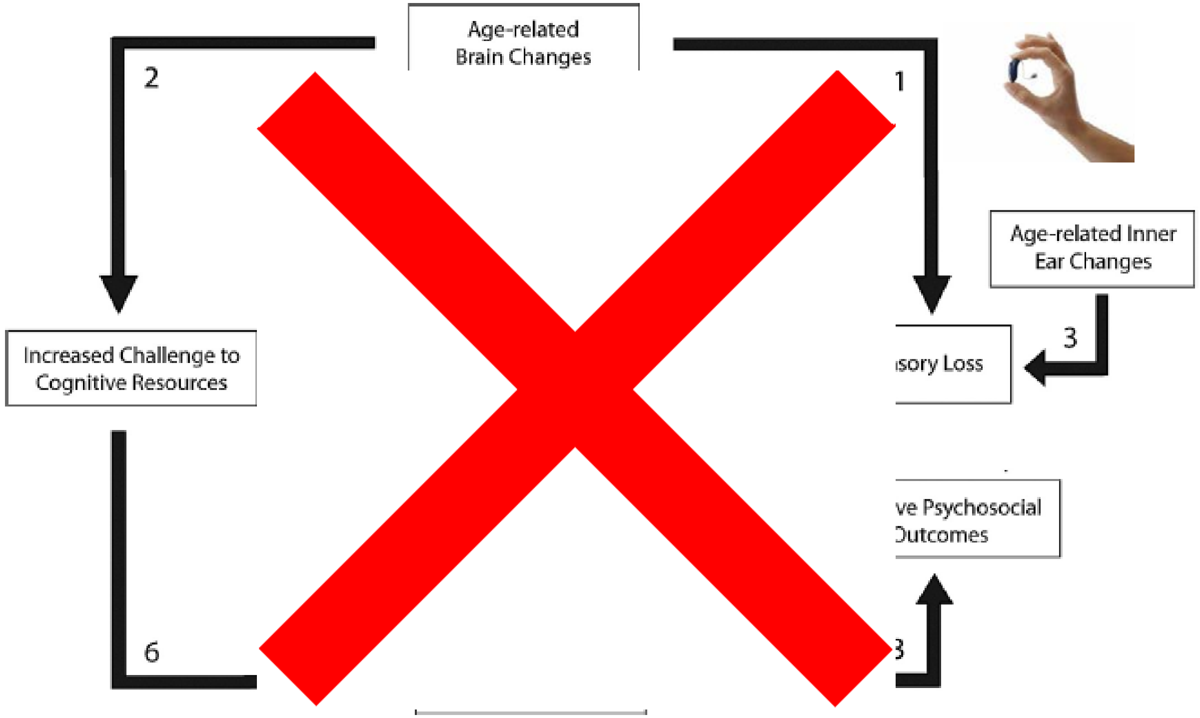


Fig. 2. An alternative framework for conceptualizing the relationship between hearing loss and cognitive decline.

Wayne RV, Johnsrude IS. (2015) A review of causal mechanisms underlying the link between age-related hearing loss and cognitive decline. Age Res Rev, 23:154–166

Original Investigation

ONLINE FIRST

March 20, 2017

Association of Antioxidant Supplement Use and Dementia in the Prevention of Alzheimer's Disease by Vitamin E and Selenium Trial (PREADViSE)

Richard J. Kryscio, PhD[1,2,3,4]; Erin L. Abner, PhD[1,2,3,5]; Allison Caban-Holt, PhD[1,2]; et al

Author Affiliations

JAMA Neurol. Published online March 20, 2017. doi:10.1001/jamaneurol.2016.5778

Editorial Comment

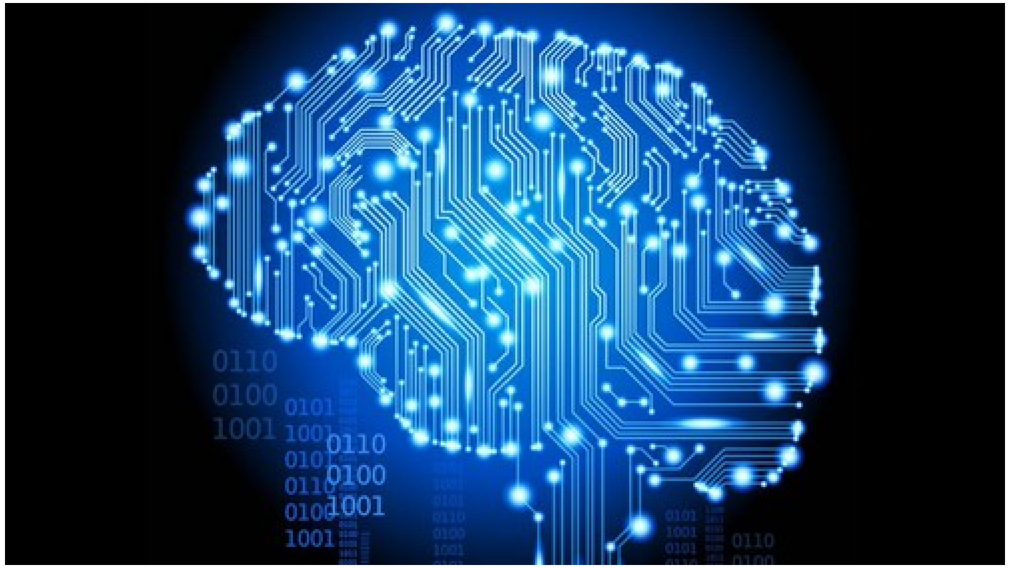
Full Text

Key Points

Question Can vitamin E or selenium prevent dementia in asymptomatic older men?

Findings The Prevention of Alzheimer's Disease by Vitamin E and Selenium trial initially enrolled 7540 elderly men who were exposed to the supplements for an average of 5.4 years; a subset of 3786 men agreed to be observed for up to 6 additional years. Dementia incidence (4.4%) did not differ among the 4 study arms.

Meaning Neither supplement is recommended as a preventive agent for dementia.



THE FUTURE

ACHIEVE

- Aging, Cognition and Hearing Intervention & Evaluation in Elders (ACHIEVE)
  - PI: Frank Lin, MD, PhD, Johns Hopkins University
  - Integrated within the Atherosclerosis Risk in Communities-Neurocognitive Study (ARIC-NCS)
- Timeline
  - 2014-2016: RCT planning process, feasibility study, development of protocol/MOP, etc.
  - 2016 Trial grant submission (NIA)
  - 2017-18 Recruitment at ARIC field sites
  - 2018-21 Follow-up

JOHNS HOPKINS
UNIVERSITY

ACHIEVE

- Study Aims
  1. To determine the effects of best-practices hearing rehabilitative treatment on rates of cognitive decline in 70-84 year-old well-functioning and cognitively-normal older adults with hearing loss
  2. To determine the effects of best-practices hearing rehabilitative treatment on health-related quality of life, social/leisure activities, daily functioning, mobility, and longitudinal brain atrophy on structural MRI
  3. To investigate the mechanistic pathways through which hearing rehabilitative treatment affects cognitive functioning by studying longitudinal changes in proximal/mediating outcome measures in relation to cognitive trajectories

ACHIEVE

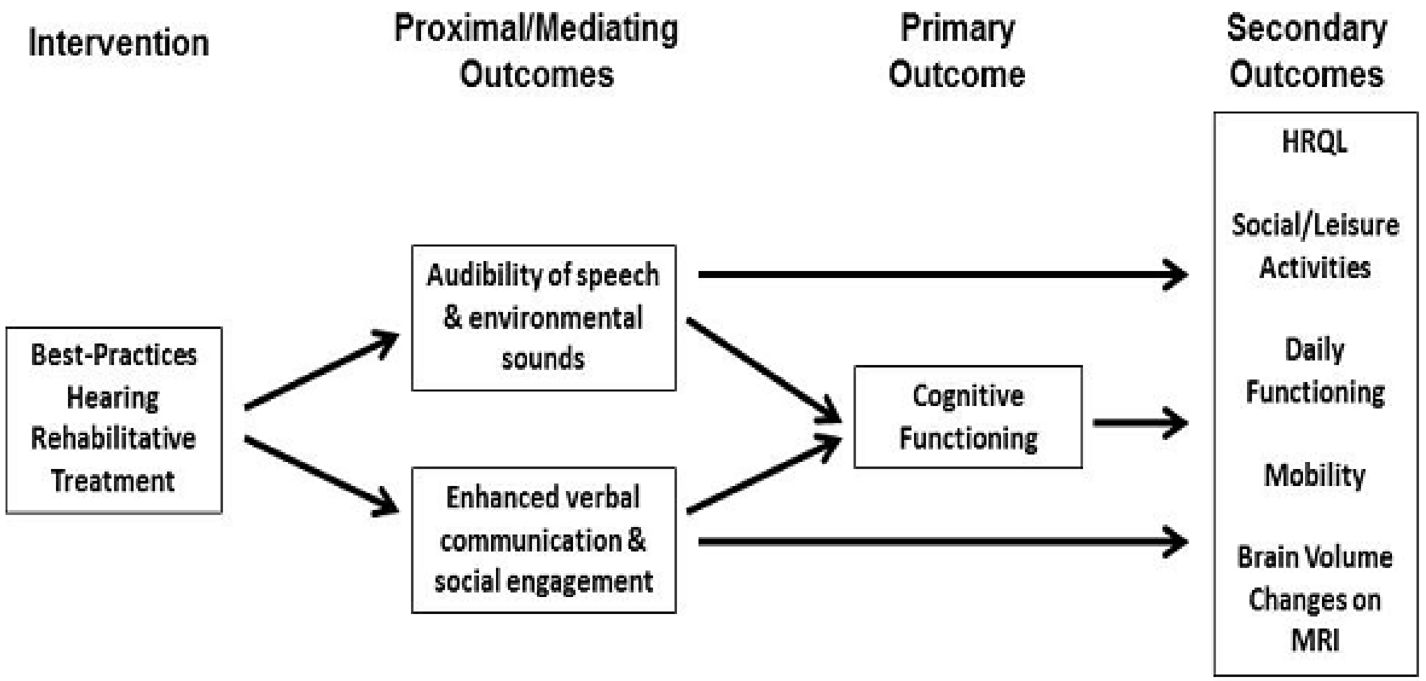


Figure 1. Conceptual model for ACHIEVE[1].

SENSE-Cog

- Ears, Eyes and Mind: The 'SENSE-Cog Project' to improve mental well-being for elderly European with sensory impairment
  - PI: Iracema Leroi, MD, PhD, University of Manchester
  - Funded by EU's Horizon 2020 Research and Innovation Program for >$5.0M€
  - 2016-2020

SENSE Cog Promoting health for eyes, ears and mind.

List of participants

#	Participant Legal Name	Country
1	THE UNIVERSITY OF MANCHESTER	United Kingdom
2	AS CYPRUS COLLEGE LIMITED	Cyprus
3	THE MANCHESTER METROPOLITAN UNIVERSITY	United Kingdom
4	ETHNIKO KAI KAPODISTRIAKO PANEPISTIMIO ATHINON	Greece
5	UNIVERSITE DE NICE SOPHIA ANTIPOLIS	France
6	UNIVERSITE DE BORDEAUX	France
7	ERASMUS UNIVERSITAIR MEDISCH CENTRUM ROTTERDAM	Netherlands
8	UNIVERSITETET I TROMSOE	Norway
9	Katholische Hochschule Freiburg gGmbH	Germany
10	Dementia Pal Ltd	United Kingdom
11	IXICO Limited	United Kingdom
12	Starkey Laboratories	United States
13	HORTECH GGMBH	Germany
14	ESSILOR INTERNATIONAL SA	France
15	GABO:MI GESELLSCHAFT FUR ABLAUFORGANISATION:MILLIARIUM MBH & CO KG	Germany
16	CHU DE NICE	France
17	UNIVERSITY OF CYPRUS	Cyprus

SENSE-Cog Promoting health for eyes, ears and mind.

SENSE-Cog

- Study Aims
  - Aim I: understand the links among hearing, vision, cognitive and emotional systems
  - Aim II: improve the early detection and diagnosis of sensory, cognitive and emotional problems
  - Aim III: determine the effectiveness of a newly developed vision and hearing support intervention

SENSE Cog Promoting health for eyes, ears and mind.

SENSE-Cog

- Aim IV: provide new information about the economic impact of sensory impairment on mental well-being and quality of life
- Aim V: raise awareness and communicate the message that sensory health (hearing and vision) is a key feature of mental well-being

SENSE Cog
Promoting health for eyes, ears and mind.

IMPLICATIONS FOR AUDIOLOGISTS

SCREENING FOR COGNITIVE DISORDERS
IN OLDER ADULTS IN THE AUDIOLOGY CLINIC

BY ROBERT W. SWEETOW

Audiologists might be reluctant to administer cognitive testing for fear that they may wound the patient's ego, therefore, it may be useful to unobtrusively incorporate a screening measure for cognitive impairment as part of the audiological and communication needs assessment.

The relationship of cognitive status to hearing aid success has been among the most frequent topics in the audiology and amplification literature in the past few years. Interest in this subject has been fueled by a series of papers from Johns Hopkins University detailing large scale studies, which have crossed over from the medical literature to the audiological world (Lin et al, 2011; Lin et al, 2013). These studies report demographics that underscore a number of factors linking cognition to hearing. For example, two-thirds of people age 70 and older have hearing loss (Chien and Lin, 2012). Older adults with hearing loss have a 24 percent higher risk of cognitive impairment when measured on non-verbal tests of memory and executive function (Lin, 2011). Numerous factors may account for these findings, including the "common cause" hypothesis (shared neural pathways), necessity for additional resource expenditure, and isolation resulting from hearing loss.

In addition, it is known that even in the absence of hearing loss, older subjects require 3–5 dB higher SNR than young listeners (Schneider, et al, 2005), and that older subjects with normal hearing perform approximately the same as young hearing impaired subjects (Wingfield and Tun, 2001). In fact, cognitive function has been cited as the strongest predictor of individual performance differences, not the audiograms (Humes, 2007). The perceptual deficits that occur with aging include negative changes in speed of processing, working memory, capacity shared between processing and storage, and attentional difficulties, including executive control (Wingfield and Tun, 2005). Furthermore, older adults with hearing loss and poor working memory are more susceptible to hearing aid distortions from signal-processing algorithms, suggesting that cognitive skills should be taken into account in the hearing aid fitting (Arehart et al, 2013).

Test	Scoring	Time to Administer	Cut Point or Score	How to Access
MMSE	11 items, scores range from 0 to 30	10 min	>24	Copyrighted for purchase at: www.minimental.com
Mini-Cog™	3 –item recall test with clock drawing test (CDT) serving as a recall distractor	3 min	0-2 positive screen for dementia	Available at: http:// geriatrics. uthscsa.edu/ tools/MINICog.pdf
MoCA	Total score–30, with eight domains of function evaluated	10 min (training recommended)	<26	www.mocatest.org
CDT	10-point scale	Varies with way in which it is administered	Depends on instructions: a normal clock (or a score of one point) indicates the absence of dementia; an abnormally completed clock warrants referral	http://www.rehabmeasures. org/PDF%20 Library/ Clock%20Drawing%20Test% 20Instructions.pdf

Beck DL, Weinstein BE, Harvey M. Issues in Cognitive Screenings by Audiologists. *Hearing Review*. 2016;23(2):36.

AJA

Tutorial

Using Cognitive Screening Tests in Audiology

Jing Shen,[a] Melinda C. Anderson,[b] Kathryn H. Arehart,[b] and Pamela E. Souza[a]

Purpose: The population of the United States is aging. Those older adults are living longer than ever and have an increased desire for social participation. As a result, audiologists are likely to see an increased demand for service by older clients whose communication difficulty is caused by a combination of hearing loss and cognitive impairment. For these individuals, early detection of mild cognitive impairment is critical for providing timely medical intervention and social support.
Method: This tutorial provides information about cognition of older adults, mild cognitive impairment, and cognitive screening tests, with the purpose of assisting audiologists in identifying and appropriately referring potential cases of cognitive impairment.
Results: Topics addressed also include how to administer cognitive screening tests on individuals with hearing loss, how to use test results in audiology practice, and the potential of using cognitive screening tests for evaluating the benefit of clinical interventions.
Conclusions: As health care professionals who serve the aging population, audiologists are likely to encounter cases of undiagnosed cognitive impairment. In order to provide timely referral for medical assistance as well as an optimized individual outcome of audiologic interventions, audiologists should be trained to recognize an abnormality in older clients' cognitive status.

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Depression Screening Tools

(with thanks to Robert Fifer)

- Adult screening tools:
  - Patient Health Questionnaire (PHQ-9)
  - Beck Depression Inventory (BDI or BDI-II)
  - Center for Epidemiologic Studies Depression Scale (CES-D)
  - Duke Anxiety-Depression Scale (DADS)
  - Geriatric Depression Scale (GDS)
  - Cornell Scale Screening
  - PRIME MD-PHQ2

Physician Quality Reporting System (PQRS)

Measure #134: Preventive Care and Screening: Screening for Clinical Depression and Follow-Up Plan

- *Required when you perform the procedure represented by 92625 (Tinnitus evaluation)*

Dementia prevention, intervention, and care

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Executive summary

Acting now on dementia prevention, intervention, and care will vastly improve living and dying for individuals with dementia and their families, and in doing so, will transform the future for society.

Dementia is the greatest global challenge for health and social care in the 21st century. It occurs mainly in people older than 65 years, so increases in numbers and costs are driven, worldwide, by increased longevity resulting from the welcome reduction in people dying prematurely. The *Lancet* Commission on Dementia Prevention, Intervention, and Care met to consolidate the huge strides that have been made and the emerging knowledge as to what we should do to prevent and manage dementia.

Globally, about 47 million people were living with dementia in 2015, and this number is projected to triple by 2050. Dementia affects the individuals with the condition, who gradually lose their abilities, as well as their relatives and other supporters, who have to cope with seeing a family member or friend become ill and decline, while responding to their needs, such as increasing dependency and changes in behaviour. Additionally, it affects the wider society because people with dementia also require health and social care. The 2015 global cost of dementia was estimated to be US$818 billion, and this figure will continue to increase as the number of people with dementia rises. Nearly 85% of costs are related to family and social, rather than medical, care. It might be that new medical care in the future, including public health measures, could replace and possibly reduce some of this cost.

Dementia is by no means an inevitable consequence of reaching retirement age, or even of entering the ninth

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Key messages

1 The number of people with dementia is increasing globally
Although incidence in some countries has decreased.

2 Be ambitious about prevention
We recommend active treatment of hypertension in middle aged (45–65 years) and older people (aged older than 65 years) without dementia to reduce dementia incidence. Interventions for other risk factors including more childhood education, exercise, maintaining social engagement, reducing smoking, and management of hearing loss, depression, diabetes, and obesity might have the potential to delay or prevent a third of dementia cases.

3 Treat cognitive symptoms
To maximise cognition, people with Alzheimer's disease or dementia with Lewy bodies should be offered cholinesterase inhibitors at all stages, or memantine for severe dementia. Cholinesterase inhibitors are not effective in mild cognitive impairment.

4 Individualise dementia care
Good dementia care spans medical, social, and supportive care; it should be tailored to unique individual and cultural needs, preferences, and priorities and should incorporate support for family carers.

5 Care for family carers
Family carers are at high risk of depression. Effective interventions, including STrAtegies for RelaTives (START) or Resources for Enhancing Alzheimer's Caregiver Health intervention (REACH), reduce the risk of depression, treat the symptoms, and should be made available.

6 Plan for the future
People with dementia and their families value discussions about the future and decisions about possible attorneys to make decisions. Clinicians should consider capacity to make different types of decisions at diagnosis.

7 Protect people with dementia
People with dementia and society require protection from possible risks of the condition, including self-neglect, vulnerability (including to exploitation), managing money, driving, or using weapons. Risk assessment and management at all stages of the disease is essential, but it should be balanced against the person's right to autonomy.

8 Manage neuropsychiatric symptoms
Management of the neuropsychiatric symptoms of dementia including agitation, low mood, or psychosis is usually psychological, social, and environmental, with pharmacological management reserved for individuals with more severe symptoms.

9 Consider end of life
A third of older people die with dementia, so it is essential that professionals working in end-of-life care consider whether a patient has dementia, because they might be unable to make decisions about their care and treatment or express their needs and wishes.

10 Technology
Technological interventions have the potential to improve care delivery but should not replace social contact.

Specific risk factors and mechanisms

Here we discuss the specific risk factors and their effects.

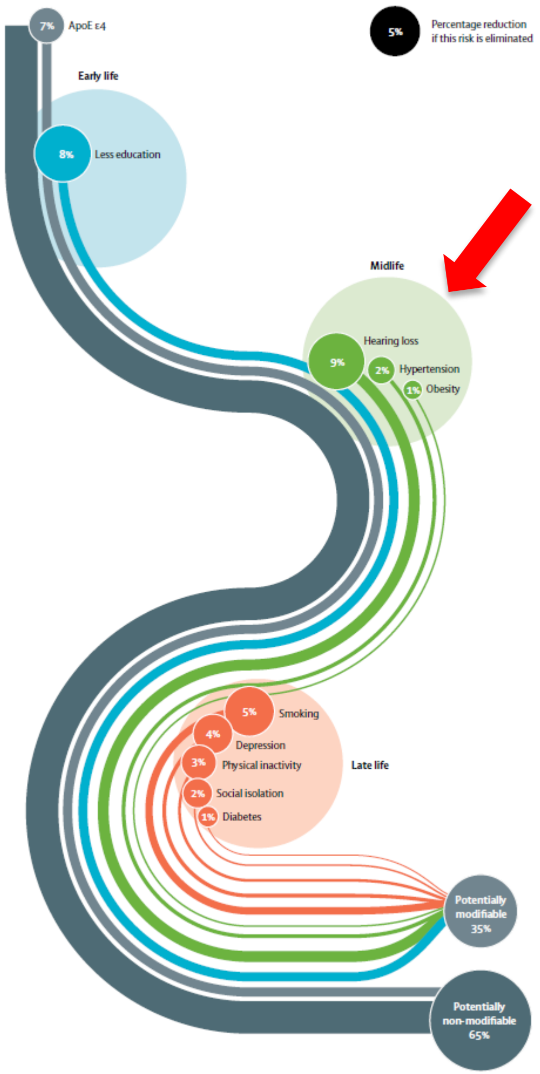
Education

Less education is associated with an RR of dementia of 1·59 (95% CI 1·26–2·01) and the high PAF is because of the large worldwide estimated prevalence of 40%. Less time in education, which we defined as no secondary school education, has the second highest PAF in our model. Low educational level is thought to result in vulnerability to cognitive decline because it results in less cognitive reserve,[58] which enables people to maintain function despite brain pathology.[80] We do not yet know whether education after secondary school is additionally protective.

Hearing

Recognition of hearing loss as a risk factor for dementia is relatively new and has not been included in previous calculations of PAF, nor has it been a priority in the management of those at risk of cognitive impairment. Results of cohort studies[65–67,81–88] that have investigated hearing have usually shown that even mild levels of hearing loss increase the long-term risk of cognitive decline and dementia in individuals who are cognitively intact but hearing impaired at baseline. However, although there are 11 positive studies, two studies[89,90] found no increased risk in adjusted analyses.

The risk of hearing loss for dementia in the meta-analysis of three studies,[65–67] which we did for this Commission (pooled RR 1·94, 95% CI 1·38–2·73; figure 3), is not only higher than the risk from other individual risk factors, but it is also pertinent to many people because it is highly prevalent, occurring in 32% of individuals aged older than 55 years.[91] Its high RR and prevalence explains the high PAF. We have used the prevalence of hearing loss in individuals older than 55 years to calculate PAF because this age was the youngest mean age in which presence of hearing loss was shown to increase dementia risk.[67] Hearing loss is therefore grouped with the midlife risk



Study	RR (95% CI)	Weight % (random)	Risk ratio
Lin et al (2011)[66]	2·32 (1·32–4·07)	27·3%	
Gallacher et al (2012)[67]	2·67 (1·38–5·17)	21·3%	
Deal et al (2016)[66]	1·55 (1·10–2·19)	51·4%	
Random effects model	1·94 (1·38–2·73)	100%	

Heterogeneity: I^2=29%, tau^2=0·0278, p=0·2445

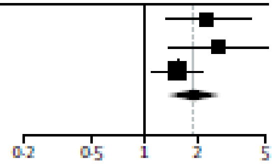


Figure 3: Forest plot of the effect of hearing loss on incidence of dementia 9–17 years later in cognitively healthy people

Hearing loss was measured by pure-tone audiometry. RR=risk ratio.

The Big Message

- Age-related hearing loss is not a benign consequence of aging
  - ARHL is associated with a number of psychosocial and physiologic comorbid conditions
- Caveat: The research suggests that the relationships between hearing loss and other chronic conditions are coincidental, not causal

To Do on Monday

- Update your history forms to include questions related to conditions associated with hearing loss
- Continue to educate yourself concerning chronic conditions associated with hearing loss

- Build and develop relationships with other professionals
  - primary care physicians
  - psychologists
  - neuropsychologists
- Screen for cognitive function and depression

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Merci Beaucoup

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