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Association of Hearing Loss with Hospitalization and Burden of Disease in Older Adults

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To the Editor

Hearing loss (HL) is a chronic condition that affects nearly 2 of every 3 adults aged 70 or older in the US.[1] Hearing loss has broader implications for older adults, being independently associated with poorer cognitive[2] and physical functioning.[3] Currently, the association of HL with other health economic outcomes, such as healthcare utilization, is unstudied. We investigated the association of HL with hospitalization and burden of disease in a nationally representative study of adults aged 70 and older.

Methods

We analyzed combined data from the 2005-06 and 2009-10 cycles of the National Health and Nutrition Examination Survey (NHANES), an ongoing epidemiological study designed to assess the health and functional status of the civilian, non-institutionalized US population.[4] Air-conduction pure-tone audiometry was administered to all individuals aged 70 and older, according to established NHANES protocols. Hearing was defined per the WHO[5] as the average of hearing thresholds (in dB) at speech frequencies (0.5-4 kHz) in the better-hearing ear (range: 0-100 dB). Data on hospitalizations and burden of disease over the previous 12 months were gathered through computer-assisted or interviewer-administered questionnaires. Hospitalization was defined as any hospitalization (yes/no) and number of hospitalizations (0/1/>1 times). Burden of disease was defined as self-reported number of days of poor physical health, poor mental health, and inactivity due to health (0-10/>10 days).[4] Data were analyzed using stepwise multivariate logistic and ordinal logistic regression models to investigate the association of HL as a continuous variable (per 25 dB) with hospitalization and burden of disease, adjusting for demographic characteristics and cardiovascular risk factors. We accounted for the complex sampling design using sample weights according to National Center for Health Statistics guidelines. Data were analyzed using Stata, version 11 (StataCorp, College Station, TX). A two-sided threshold of $p < .05$ was used to evaluate statistical significance. The NHANES protocol (#2005-06) was

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Author Contributions: Drs. Genther and Lin had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of Interest Disclosures: Dr. Lin serves as a consultant for Pfizer, Autifony, and Cochlear Americas and has been a speaker for Cochlear and Amplifon. All other authors do not report any conflicts of interest.

reviewed and approved by the National Center for Health Statistic's Institutional Review Board (IRB) and informed written consent was obtained from all participants.

Results

Compared to individuals with normal hearing (n=529), individuals with HL (n=1140) were more likely to be older (mean age: 74.7 vs. 77.0 years), male, white, less educated, in lower income households, have a positive history for cardiovascular risk factors, and to have a history of hospitalization in the past year (Table 1).

Fully adjusted models accounting for demographic and cardiovascular risk factors demonstrated that HL (per 25 dB) is significantly associated with any hospitalization (OR: 1.32, 95% CI: 1.07 – 1.63), number of hospitalizations (OR: 1.35, 95% CI: 1.09 – 1.68), >10 days of self-reported poor physical health (OR: 1.36, 95% CI: 1.06 – 1.74), and >10 days of self-reported poor mental health (OR: 1.57, 95% CI: 1.20 – 2.06) (Table 2). HL was not associated with days of self-reported inactivity due to health.

Comment

For adults aged 70 and older, HL is independently associated with hospitalization and poorer self-reported health over the past 12 months. This is to our knowledge the first nationally representative study to demonstrate that HL is independently associated with increased healthcare utilization and burden of disease among older adults. Pathways through which HL could contribute to the odds of hospitalization and poorer self-reported health include social isolation[6] and effects on cognitive decline and dementia.[2] Alternatively, residual confounding by unmeasured factors not accounted for in our analyses (e.g., subclinical microvascular disease) could also underlie the observed associations. A principle limitation of our cross-sectional study is that we cannot determine the temporal course and mechanisms through which hearing loss could be associated with hospitalization and burden of disease. Future economic analyses of the impact of HL may need to take into account these potential broader implications of HL on the health and functioning of older adults. Additional research is needed to investigate the basis of these observed associations and whether hearing rehabilitative therapies could possibly help reduce hospitalizations and improve self-reported health in older adults with HL.

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Acquisition of data: Genther and Lin.

Analysis and interpretation of data: Genther, Frick, Chen, Betz, and Lin

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Table 1

Demographic characteristics[a] of participants aged 70 years or older with audiometric testing, National Health and Nutrition Examination Survey (NHANES), 2005-6 & 2009-10[b]

Characteristic	Normal hearing (n=529)	Hearing loss (n=1140)	P-value[c]
Age, years			<.001
70-74	289 (54.6)	319 (30.0)	
75-79	138 (26.1)	283 (24.8)	
≥80	102 (19.3)	538 (47.2)	
Degree of hearing loss[d]			
Mild	-	590 (51.8)	
Moderate	-	446 (39.1)	
Severe	-	97 (8.5)	
Profound	-	7 (0.6)	
Any hospitalization	99 (18.7)	271 (23.8)	.02
Number of hospitalizations (mean, 95% CI)	1.27 (1.13-1.41)	1.52 (1.40-1.64)	.03
Days of poor physical health (mean, 95% CI)	4.48 (3.69-5.26)	4.98 (4.39-5.56)	.33
Days of poor mental health (mean, 95% CI)	2.49 (1.90-3.08)	2.23 (1.99-2.64)	.46
Days inactive due to health (mean, 95% CI)	1.91 (1.36-2.46)	2.33 (1.90-2.76)	.26
Male sex	217 (41.0)	631 (55.4)	<.001
Race[e]			<.001
White	327 (61.8)	859 (75.3)	
Black	117 (22.1)	117 (10.3)	
Hispanic	68 (12.9)	131 (11.5)	
Other	17 (3.2)	33 (2.9)	
Education			.003
<12th grade	161 (30.4)	428 (37.5)	
High school graduate	128 (24.2)	300 (26.3)	
Some college or greater	239 (45.2)	410 (36.0)	
Refused/Don't know	1 (0.2)	2 (0.2)	
Household annual income, USD			.002
<20,000	129 (24.4)	353 (31.1)	
20,000-44,999	176 (33.3)	406 (35.8)	
≥45,000	185 (35.0)	301 (26.5)	
Refused/Don't know	39 (7.4)	75 (6.6)	
Hypertension	353 (66.9)	703 (61.9)	.05
Diabetes mellitus	113 (21.4)	247 (21.7)	.89
Stroke	38 (7.2)	130 (11.4)	.008
Cardiovascular disease[f]	103 (19.5)	307 (27.0)	.001
Smoking history			.24
Current	258 (48.8)	534 (46.8)	
Former	226 (42.7)	529 (46.4)	

Characteristic	Normal hearing (n=529)	Hearing loss (n=1140)	P-value[c]
Never	45 (8.5)	77 (6.8)	
Type of health insurance			.67
Private only	11 (2.1)	16 (1.4)	
Medicare only	223 (42.2)	460 (40.4)	
Private & Medicare	283 (53.5)	630 (55.3)	
Other	3 (0.6)	13 (1.1)	

Abbreviations: USD, United States dollars; CI, confidence interval

[a]Demographic characteristics are unweighted to give descriptive statistics on the characteristics of the study cohort rather than nationally generalizable estimates.

[b]All values are expressed as number(%), unless otherwise noted. Presence of hearing loss is defined as the average of hearing thresholds (0.5-4 kHz) in the better hearing ear of 25 dB or greater.

[c]For binary and categorical variables the chi-square test was used, and for continuous variables the two-sample t-test was used to evaluate for differences between the normal hearing and hearing loss groups.

[d]Degree of hearing loss is defined by the average of hearing thresholds (0.5-4 kHz) in the better hearing ear: mild, 25-39 dB; moderate, 40-59 dB; severe, 60-84 dB; profound, ≥85 dB.

[e]Designation of race is based upon self-report by the study participant.

[f]Includes any or all of the following: history of myocardial infarction, history of angina, diagnosis of coronary artery disease, diagnosis of congestive heart failure

Table 2

Association of hearing loss[a] (per 25 dB) with any hospitalization, number of hospitalizations, and burden of disease in the previous 12 months, National Health and Nutrition Examination Survey (NHANES), 2005-6 & 2009-10

	Base model (hearing loss [per 25dB], age[f])			Base model + demographic factors[2]			Base model + demographic factors + cardiovascular risk factors[3]		
	n[b]	OR (95% CI)[c]	P-value	n	OR (95% CI)	P-value	n	OR (95% CI)	P-value
Healthcare Utilization									
Any hospitalization[d]	1666	1.33 (1.08 – 1.65)	.008	1658	1.34 (1.09 – 1.65)	.006	1646	1.32 (1.07 – 1.63)	.01
Number of hospitalizations[e]	1666	1.36[f] (1.10 – 1.67)	.005	1661	1.36[f] (1.11 – 1.68)	.005	1649	1.35[f] (1.09 – 1.68)	.007
Burden of Disease									
>10 days self-reported poor physical health	1570	1.32 (1.06 – 1.64)	.02	1562	1.35 (1.06 – 1.73)	.02	1552	1.36 (1.06 – 1.74)	.02
>10 days self-reported poor mental health	1568	1.25 (0.97 – 1.61)	.09	1560	1.54 (1.19 – 1.99)	.002	1550	1.57 (1.20 – 2.06)	.002
>10 days self-reported inactivity due to health	1570	1.09 (0.72 - 1.67)	.66	1562	1.04 (0.68 – 1.58)	.87	1552	1.02 (0.67 – 1.56)	.93

Abbreviations: OR, odds ratio; CI, confidence interval

[a] Hearing loss (per 25dB) is defined by the average of hearing thresholds (0.5-4 kHz) in the better hearing ear.

[b] Number of subjects included in each model. Individuals with missing data for a given model were excluded from that model. For analyses of hospitalization, missing data comprised <1.1% of the dataset, and for burden of disease, missing data comprised less than <7.1% of the dataset.

[c] OR (with 95% CI) of hospitalization or burden of disease, per 25 dB of hearing loss

[d] Any hospitalization in the past 12 months (yes, no)

[e] Number of hospitalizations in the past 12 months (0, 1, >1)

[f] OR represents the odds of the *next higher* categorical number of hospitalizations.

[1] Age is adjusted for as a categorical variable (70-74, 75-79, ≥80). NHANES reports individuals with age ≥80 as 80 years to ensure participant confidentiality.

[2] Demographic factors include sex, race, level of education, and annual household income.

[3] Cardiovascular risk factors include hypertension, stroke, diabetes mellitus, and cardiovascular disease (myocardial infarction, coronary artery disease, angina, congestive heart failure), smoking history (current, former, never).