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## Hearing Loss and Depression in Older Adults

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### TO THE EDITOR

Hearing loss (HL) is a common, but underappreciated health issue affecting older adults. The functional consequences of HL for older adults are now surfacing in epidemiological studies demonstrating that HL may be independently associated with depression<sup>1</sup> and loneliness.<sup>2</sup> Compared to other medical co-morbidities, HL is more strongly associated with the development of depression in older adults.<sup>1</sup> Whether hearing rehabilitative treatment may mitigate the possible effects of HL on depression remains unclear. We investigated the association of HL and hearing aid use with major depressive disorder (MDD) in a nationally representative study of older patients.

### METHODS

We analyzed data from the 2005–2006 and 2009–2010 two-year cycles of the National Health and Nutrition Examination Survey (NHANES), an epidemiological study designed to assess the health, functional, and nutritional status of the civilian, non-institutionalized United States population. During these survey cycles, audiometry was performed in adults aged 70 years and older. Participants were also administered the patient health questionnaire (PHQ-9),<sup>3</sup> a self-reported depression assessment instrument based on Diagnostic and Statistical Manual IV signs and symptoms of MDD. Our analytic cohort consists of 1029 adults aged 70 through 79 years who completed audiometric testing as well as the PHQ-9.

Hearing was defined by the speech-frequency pure tone average of hearing thresholds at 0.5, 1, 2, and 4 kHz in the better hearing ear. Participants were classified as having MDD or any depressive symptoms if either of the initial questions addressing depressed mood was answered as “more than half the days” or “nearly every day” and the PHQ-9 score was 10 or 5, respectively. Scores 10 have an 88% sensitivity/specificity for MDD, while scores 5 represent mild depression.<sup>4</sup>

Data were analyzed using stepwise multivariate logistic models to investigate the association of HL as a continuous variable (per 25 dB) and hearing aid use with MDD and any depressive symptoms, adjusting for demographic characteristics and cardiovascular risk factors. Hearing aid use was defined as wearing a hearing aid at least 5 hours a week in the

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twelve months prior to the interview. All significance tests were two-sided with a type I error rate of 0.05. All analyses were performed using SAS version 9.3.

## RESULTS

At baseline, 602 (58.5%) participants had a >25 dB HL, 38 (3.9%) participants met criteria for MDD, and 71 (7.4%) participants met criteria for having any depressive symptoms. Greater HL (per 25 dB) was not significantly associated with an increased odds of MDD (OR=1.63, 95% CI: 0.66, 4.98), or any depressive symptoms (OR=1.58, 95% CI: 0.77, 3.25). Hearing aid use was associated with reduced odds of MDD (OR=0.35, 95% CI: 0.14–0.90) and any depressive symptoms (OR= 0.33, 95% CI: 0.14, 0.77) in the fully adjusted model (Table 2).

## DISCUSSION

Our results demonstrate that hearing aid use is significantly associated with a reduced odds of MDD and any depressive symptoms, consistent with prior studies.<sup>5,6,7,8</sup> Two small single arm prospective studies showed reductions in depressive symptoms within 3 months of hearing aid use.<sup>7,8</sup> Similar results have been demonstrated in the Blue Mountains Study in which hearing aid use was associated with a reduced odds (OR =0.32) of having depressive symptoms.<sup>5</sup> Prospective longitudinal studies in nursing home participants have shown similar reductions in depressive symptoms (OR= 0.30)<sup>6</sup> and improvement in mental health in ambulatory patients with hearing aid use.<sup>8</sup> The strength of our study is the utilization of the PHQ-9 to evaluate for depressive symptomatology and also MDD. Furthermore, our results are based on a generalizable cohort of older adults.

The direction of the observed association between hearing aid use and depression cannot be determined in the present study. For example, individuals without depression may be more likely to obtain hearing aids than individuals who are depressed. Alternatively, individuals who are more health conscious and less likely to have depressive symptom may also be more likely to use hearing aids. However, it is equally possible that hearing loss treatment could also plausibly help promote social engagement and thereby reduce depressive symptoms.<sup>8</sup>

Interestingly, in the present analysis, hearing loss was not associated with greater odds of having MDD or any depressive symptoms in contrast to other cross sectional and prospective longitudinal studies evaluating depressive symptomatology.<sup>1,5,9,10</sup> One possible explanation for this observation is because of the small number of participants who met the strict criteria for MDD based on the PHQ-9 guidelines.

In summary, hearing aid use is independently associated with reduced odds of MDD and depressive symptoms. The basis of this association and whether hearing rehabilitative interventions could actually reduce depressive symptoms will require further study in other prospective studies or a randomized clinical trial.

## Acknowledgments

### Conflict of Interest

Dr. Lin was supported by a grant from the National Institutes of Health (1K23DC011279), a Triological Society/ American College of Surgeons Clinician Scientist Award, and the Eleanor Schwartz Charitable Foundation.

Dr. Lin has served as a consultant to Cochlear Corp & Autifony and serves on the scientific advisory board for Autifony, as well as speaker for Amplifon & Cochlear Corps.

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**Table I**

\*Demographic Characteristics of Participants aged 70–79 Years, National Health and Nutritional Examination Surveys, 2005–2006 & 2009–2010.

<b>Characteristic Cohort (n=1029)</b>	
<b>Female</b>	501 (48.7)
<b>Age, Mean (S.D.), y</b>	73.9 (2.8)
<b>Race</b>	
<i>White</i>	668(64.9)
<i>Black</i>	184 (17.9)
<i>Mexican American</i>	112 (10.9)
<i>Other Hispanic</i>	35 (3.4)
<i>Other-Including Multiracial</i>	30 (2.9)
<b>Hearing Aid Use</b>	130 (12.7)
<b>Hearing Loss Category</b>	1029
<i>Normal( &lt;25 dB)27</i>	(41.5)
<i>Mild (&gt;25–40 dB)</i>	368 (35.8)
<i>Moderate (&gt;40–70 dB)221</i>	(21.5)
<i>Severe (&gt; 70 dB)13</i>	(1.3)
<b>Education</b>	
<i>Less than High School</i>	346 (33.7)
<i>High School Graduate</i>	281 (27.3)
<i>Some College</i>	401 (39.0)
<b>Smoking</b>	
<i>Current</i>	104(10.1)
<i>Former</i> 475	(46.2)
<i>Never</i> 450	(43.7)
<b>Hypertension</b>	671 (65.4)
<b>Stroke</b>	87 (8.5)
<b>Diabetes</b>	246 (23.9)
<b>Major Depressive Disorder, PHQ</b>	1038 (3.9)
<b>Any Depressive Symptoms, PHQ</b>	5 71 (7.4)

Abbreviations: SD = standard deviation. Percent values may not equal to 100 due to rounding.

All values are expressed as No. (%) of participants unless otherwise indicated. These are not nationally generalizable estimates, rather descriptive statistics of the study cohort.

**Table 2**

Stepwise Logistic Regression Models of the Odds of Major Depressive Disorder or Any Depressive Symptoms per 25 dB of Hearing Loss<sup>b</sup> and hearing aid use

Variable <sup>a</sup>	Odds Ratios (95% CI)			
	Major Depressive Disorder		Any Depressive Symptoms	
	BPTA per 25 db	HL Hearing Aid Use	BPTA per 25 db	HL Hearing Aid Use
Base Model (HL + HA)	1.50 (0.74, 3.04)	0.28 (0.13, 0.60) **	1.63 (0.90, 2.97)	0.27 (0.12, 0.59) **
Base				
+ Demographic Factors	1.59 (0.63, 4.03)	0.34 (0.14, 0.83) *	1.54 (0.76, 3.14)	0.34 (0.15, 0.79) *
Base				
+ Demographic Factors	1.63 (0.66, 4.02)	0.35 (0.14, 0.90) *	1.58 (0.77, 3.25)	0.33 (0.14, 0.77) *
+ Cardiovascular Factors				

Abbreviations: CI, confidence interval. BPTA, better ear pure tone average (per 25 dB loss).HA, hearing aid use, HL, Hearing Loss.

\* p<0.05;

\*\* < 0.0001

<sup>a</sup>Demographic factors include age, gender, race/ethnicity, and education; cardiovascular risk factors include hypertension, diabetes mellitus, smoking status, stroke.

<sup>b</sup>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