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Age-Related Hearing Loss and its Association with Depression in Later Life

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Abstract

Objectives—To evaluate the association between age-related hearing loss (ARHL) and depressive symptoms in older adults over time.

Methods—Data from the Health Aging and Body Composition study (N=3075, aged 70–79 at baseline) were used previously to conduct a longitudinal latent class analysis to evaluate depression trajectories (Center for Epidemiologic Studies Depression [CES-D] Scale) over 10 years. Restricting to the subset of subjects who had hearing information available (N=1204), self-reported hearing categories were evaluated over the same period. Association between depression

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classes and hearing categories were assessed via multinomial logistic regression analyses. Correlation analyses and two-sample t-tests were used to assess cross-sectional associations between depression status and audiometric hearing measures.

Results—Low-probability (N=644), increasing-probability (N=385), and high-probability (N=175) trajectories of depressive symptoms were identified for the 10-year period. Impaired/Worsening (N=182) and Healthy/Improving (N=1,022) hearing categories were defined using self-reports. With the low-probability depression trajectory as the reference group, subjects reporting Impaired/Worsening hearing had 1.63 times increased odds of having an increasing- (p=0.0088, 95% CI [1.13, 2.34]) and 1.85 times increased odds of having a high-probability depression trajectory (p=0.0102, 95% CI [1.16, 2.96]). At Year 5, individuals with depressive symptoms (10CES-D≥10) had impaired hearing ability measured by audiometric threshold for low-frequency (Adjusted mean difference=2.29 dBHL, p=0.0005) and mid-frequency sounds (Adjusted mean difference=2.28 dBHL,p=0.0049) compared to those with 10CES-D < 10.

Conclusions—ARHL was associated with increased depressive symptoms in older adults. Future studies should investigate whether treatment of ARHL may be an effective prevention and/or therapeutic strategy for depressive symptoms.

Objectives

Age-related hearing loss (ARHL) is the third most common health condition affecting older adults after heart disease and arthritis (1). While historically considered a benign effect of aging, ARHL is in fact associated with significant psychological and medical morbidity, including social isolation, frailty, and falls (2). The prevalence of ARHL approximately doubles every decade of life from the second through seventh decade, from 3% among adults 20-29, to 45% of adults 60-69, to above 80% in individuals over 80 years (3–5). Currently, hearing loss affects 28 million Americans and is expected to increase as the population continues to skew older (6).

Recently, ARHL has been associated with the development of significant neuropsychiatric dysfunction, including late-life depression (LLD) (7–14). However, discrepant reports have prevented the establishment of a firm link between ARHL and LLD, possibly due to methodological limitations of previous work. For instance, many studies rely exclusively on self-reports (as opposed to audiometric testing) for data on hearing capability, which may introduce significant bias. Few studies utilize psychometrically valid assessments with cut-points that have demonstrated relationships with clinical diagnoses of Major Depressive Disorder, and others link hearing loss to novel composite indices of emotional health whose association to LLD has not yet been validated (15). Finally, the majority of studies are cross-sectional in design and therefore cannot determine whether hearing loss is associated with incident depressive symptoms over time. Higher quality longitudinal studies comparing audiometric data with standardized assessments for depressive symptoms are needed to better understand the relationship between hearing loss and LLD.

Determining whether hearing represents a distinct age-related process capable of contributing to LLD could facilitate development of rationally designed and age-appropriate treatment approaches tailored to the underlying pathophysiology. Recent research has

focused on the causative aging-related processes involved in LLD in order to disentangle its etiologic complexity and identify targets for precision interventions. Whether hearing aids or cochlear implantation may mitigate increased risk for LLD remains unclear, but initial prospective studies have suggested that remediation of hearing has been associated with reduced depressive symptoms (16–21). If true, it would be advantageous to identify and treat individuals at risk for LLD that may prevent the full-blown (and potentially less treatable) syndrome of LLD.

In this study, we used longitudinal data from the Health Aging and Body Composition Study to examine the relationship between ARHL and longitudinal trajectories of depressive symptoms. We hypothesized that the diminished hearing capacity (as measured using self-reports as well as comprehensive audiometric evaluation) would be associated with depressive symptoms both cross-sectionally and over the 10-year follow-up period.

Methods

Study Participants

The Health ABC study is a National Institute of Aging project launched in 1997 to characterize the extent of change in body composition in older adults and examine the impact of these changes. Data were obtained in November 2013 and comprise 3,075 persons aged 70-79 years at baseline. Participants were eligible if they reported (i) no difficulty in activities of daily living with (ii) no baseline mobility limitation (difficulty walking ¼ mile or up to 10 stairs without resting). Details regarding selection criteria and Health ABC methodology were previously published (22–23). In the event that participants were unable to respond for themselves, the study contacted the participant's spouse in order to complete the assessments. For this study we included a total of 1,204 participants who had self-reported hearing loss data available at Years 1, 5, and 11.

Hearing Assessments

Hearing loss was measured with standardized self-reports at Years 1, 5, and 11. Each individual was asked "Can you hear well enough to carry on a conversation in a crowded room?" and responses were coded using a dichotomous variable (0 = no hearing loss, 1 = hearing loss). Prior studies have demonstrated validity for single-question hearing screens in identifying disabling hearing loss similar to that of more extensive screening questionnaires (24). Self-reported hearing data from Years 1, 5, and 11 of the Health ABC Study was utilized to characterize longitudinal hearing category over the 10-year study period. Participants were classified as Healthy (0 at Years 1, 5 and 11), Improving (1 at Year 1 and/or Year 5 and 0 at Year 11), Worsening (0 at Year 1 and/or Year 5 and 1 at Year 11), or Impaired (1 at Years 1, 5 and 11).

Audiometric evaluations were conducted at Year 5. Air conduction thresholds were obtained for audiometric frequencies between 250 and 8,000 Hz using a portable audiometer (Maico MA40) and supra-aural earphones (TDH 39). Testing was completed in a sound-attenuating booth meeting ANSI standards. Hearing thresholds were measured in decibels (dBHL) and the pure-tone average (PTA) was calculated for the better and worse hearing ear. When

measures for only one ear were available, the value from the one available ear was used in the analysis. For this analysis, we characterized PTA using clinically defined cut points (normal hearing: ≤ 25 dBHL, hearing loss: >25 dBHL). Frequencies of sound were defined as low (<500Hz), mid (500-2000Hz) and high (>2000Hz) (25). At Year 5, audiometric data were utilized to examine the cross-sectional relationship between audiometrically-defined AHRL and depression status as well as self-reported hearing category.

Hearing aid use was also self-reported at Years 1, 5, and 11 (0 = no hearing aid, 1 = hearing aid). Using these data from Years 1, 5, and 11, participants were classified as Never Users (0 at Years 1, 5 and 11), Decreasing Users (1 at Year 1 and/or Year 5 and 0 at Year 11), Increasing Users (0 at Year 1 and/or Year 5, 1 at Year 11), or Always Users (1 at Years 1, 5 and 11).

Depressive Symptoms

Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression (CES-D) Scale. In the Health ABC study, the standard 20-item CES-D (scores ranging from 0 to 60) was assessed at Years 1, 4, 6, 8, and 10, and an abbreviated 10-item CES-D (10CES-D, scores ranging from 0 to 30) was used at Year 5. Data from the full Health ABC study (N=3075) were used in a previous study to conduct a longitudinal latent class analysis to evaluate trajectories of depressive symptoms over 10 years (26). The depression trajectories utilized data from the standard 20-item CES-D at Years 1, 4, 6, 8, and 10 and served as the key outcome measure. The depression trajectories used a cut point of the standard 20-item CES-D ≥ 10 to represent significant subthreshold depressive symptoms, which has been associated with greater disability and adverse health outcomes in older adults (27–28). The depression trajectory for each subject was categorized into one of three classes: (i) increasing probability of depressive symptoms, (ii) consistently high probability of depressive symptoms, or (iii) consistently low probability of depressive symptoms (26). After defining depression trajectories in the full sample, the present analytic sample was restricted to the subset of Health ABC subjects who had hearing information available (N=1204).

As audiometric data was only available at Year 5, the abbreviated 10-item CES-D permitted the examination of the relationship between audiometrically-defined hearing loss and depressive symptoms, the latter both as a continuous measure and as a categorical variable. The participants' Year 5 depression status was classified as *no depressive symptoms*: 10CES-D score < 5; *mild depressive symptoms*: 10CES-D score ≥5 and < 10; *high depressive symptoms*: 10CES-D score ≥ 10. To assess the relationship between audiometrically-defined hearing loss and depressive symptoms we utilized the cut point of the abbreviated 10CES-D ≥ 10 to denote high depressive symptoms, which has shown good predictive accuracy compared to the standard 20-item CES-D cut point of ≥ 16 (29).

Statistical Analysis

Baseline characteristics of the analyzed subjects were assessed using means and standard deviations for continuous measures and percentages for categorical measures. These characteristics were compared between the Healthy/Improving and Impaired/Worsening

hearing groups using two-sample t-tests for continuous measures and Chi-squared tests for categorical measures. Associations between audiometry measures (air conduction thresholds) and self-reported hearing status at Year 5 were assessed via two-sample t-tests. Associations between audiometry measures and 10CES-D-based depression status at Year 5 were assessed using multiple linear regression models. For each audiometry measure, we fit a linear regression model with that audiometry measure as the outcome and with depression status, age, gender, race, and number of medical comorbidities as covariates. We report the model-based adjusted mean difference in the audiometry measures between depressed and non-depressed subjects and test if corresponding slope coefficient from the model is different from zero. Associations between 10CES-D at Year 5 and audiometry measures were assessed by estimating and testing partial correlation coefficients, adjusting for age, gender, race, and number of medical comorbidities. The association between depression trajectory class and self-reported hearing category was assessed using a multinomial logistic regression model with depression trajectory class entered as the outcome, the binary self-report hearing category entered as the primary predictor, and age, race, gender, and education entered as covariates. As a secondary analysis, a similar model was fit with hearing aid use category entered as the primary predictor. Analyses were conducted in SAS version 9.4.

Results

Participant Demographic and Clinical Characteristics

Table 1 provides the demographic information for the total sample and for each of the two hearing categories. The cohort originally comprised four different self-reported hearing categories: 820 (68.1%) Healthy, 202 (16.8%) Improving, 150 (12.5%) Worsening, and 32 (2.6%) Impaired. Given the relatively small number of subjects in the Impaired category, we opted to simplify the categories and consider contrasts between those in the Healthy/Improving group and those in the Impaired/Worsening group. At baseline, there were some significant differences between the two hearing categories, for example those with Impaired/Worsening hearing were more likely to be male (62.1% vs. 43.2% male, $p < 0.0001$), white (74.7% vs. 64.3% white, $p = 0.0065$), and older (mean age 73.7 vs. 73.0 years, $p = 0.002$). At baseline, there were no significant differences in depressive symptoms between hearing groups. In addition, 931 (77.5%) of the sample reported never using a hearing aid, while 271 (22.5%) reported hearing aid use for at least some portion of the study period (2 subjects did not have information on hearing aid use).

Longitudinal Relationship between ARHL and Depressive Symptoms over 10-year Follow-up

Classification of participants based on longitudinal trajectories of depressive symptoms revealed three distinct trajectories: consistently low probability, increasing probability, or consistently high probability of depression. In the sample, 644 (53.5%) had a low-, 385 (32.0%) had an increasing-, and 175 (14.5%) had a high-depression trajectory. Overall, self-reported hearing category (Healthy/Improving vs. Impaired/Worsening) was a significant predictor of depression trajectory, adjusting for age race, gender, and education ($p = 0.0071$). The odds of having an increasing compared to a low depression trajectory for subjects with

Impaired/Worsening hearing were 1.63 times the odds of subjects with Healthy/Improving hearing after adjusting for age, race, gender, and education [p = 0.0088, 95% CI (1.13, 2.34)]. The odds of having a high compared to a low depression trajectory for subjects with Impaired/Worsening hearing were 1.85 times the odds of subjects with Healthy/Improving hearing, adjusting for age, race, gender, and education [p = 0.0102, 95% CI (1.16, 2.96)].

We were also interested in exploring whether self-reported hearing aid use was predictive of depressive symptoms, but we relegated this to an exploratory analysis given that compliance rates with hearing aids are often low and inaccurately reported. We found that hearing aid use was not significantly associated with depression trajectory after adjusting for age, race, gender, and education. However, the study did not utilize any empirical measures of hearing aid use to correlate with the self-report data.

Cross-sectional Relationship between ARHL and Depressive Symptoms at Year 5

As shown in Table 2, there were significant cross-sectional relationships identified between audiometrically-defined hearing loss and depression category (10CES-D ≥ 10) as well as continuous 10CES-D scores at low- and mid-, but not high-frequency sounds. For example, on average, those with 10CES-D ≥ 10 tended to have worse hearing for low-frequency sounds (mean hearing threshold 26.4 vs. 24.0 dBHL respectively, p = 0.0005) and for mid-frequency sounds (mean hearing threshold 28.4 vs. 26.7 dBHL respectively, p = 0.0049) compared to those with 10CES-D < 10. Continuous 10CES-D scores were positively correlated with audiometric hearing loss at low-frequency sounds (partial r = 0.11, p = 0.0002) and mid-frequency sounds (partial r = 0.09, p = 0.0042) after adjusting for age, gender, race, and medical comorbidities. Notably, at Year 5 of the study there was a statistically significant cross-sectional association between self-reported hearing category and audiometrically-defined AHRL in both ears across all hearing frequencies 250-8000hz (e.g., at the 1000Hz hearing threshold, those reporting hearing loss had mean threshold of 31.6 dBHL while those reporting no hearing loss had mean threshold of 24.1 dBHL in the left ear (p < 0.0001); mean threshold values in the right ear were 29.8 dBHL vs. 24.3 dBHL respectively (p < 0.0001)).

Conclusions

The primary study finding was that ARHL is associated both cross-sectionally and longitudinally with increased depressive symptoms in otherwise healthy older adults. Compared to those without hearing loss, individuals with ARHL had 1.63 times the odds of having an increasing depressive symptom trajectory and 1.85 times the odds of having a consistently high depressive symptom trajectory over 10-year follow-up. The association between ARHL and depressive symptoms appeared to be both statistically significant and clinically meaningful, as hearing loss was associated not only with a continuous measure of depressive symptoms, but also with CES-D scores ≥10, a level used to define significant depressive symptoms that denote risk for adverse outcomes (27–28). This finding extends the previous literature by linking ARHL to depressive symptoms measured with a validated scale as opposed to less reliable screening tools or newly defined constructs of emotional health (15). Furthermore, whereas previous studies examined the relationship between

ARHL and depressive symptoms at single time points, we utilized longitudinal data to track the relationship between these variables over time. This methodology may be a more sensitive indicator for the strength of the relationship, since ARHL develops insidiously over a period of years and there may be particular vulnerable periods or thresholds for the development of LLD.

We also observed a cross-sectional relationship at Year 5 between ARHL and 10CES-D scores, which was notable at low- and mid-, but not high-frequency sounds. This pattern of results fits with the literature describing the types of disability conferred by ARHL, as low frequency sounds are most important to understand vowels, and mid-frequency sounds are characteristic of human speech in quiet environments (30), while high-frequency sounds may be less clinically relevant. Many hearing-impaired older adults avoid or withdraw from social contexts in which background noise will make it difficult to communicate (31), resulting in social isolation and reduced communication with family and friends (32). Observational studies of older adults have reported associations between ARHL and impaired social functioning (33), and reduced social interaction has been linked to the development of depressive symptoms (34). While the cross-sectional correlations between 10CES-D score and audiometric measures are modest, this is not surprising given the complex and multifactorial nature of depression etiology. The fact that ARHL has even a weak relationship with depression is exciting, given hearing loss's extremely high prevalence and low treatment levels. In addition, it has been suggested that even small differences in hearing can be clinically significant to patients (35).

It was perhaps not surprising to find that self-reported hearing aid use was not protective against the development or exacerbation of depressive symptoms, as hearing aid utilization rates are surprisingly low (4.3% in individuals 50–59 years, to 22.1% in individuals ≥ 80 years) and no data on compliance rates were available for analysis (36). The few studies available have reported that self-reported hearing aid use overestimates actual usage as compared to objective data logging methods (37–38).

Placing these results in context of previous studies on ARHL and neuropsychiatric dysfunction, it is intriguing to speculate that treating ARHL may be protective and/or therapeutic for individuals who would otherwise go on to develop LLD. Preliminary studies have found that hearing rehabilitative treatment may be helpful for depressive symptoms, including a recent prospective analysis that found an association between cochlear implant or hearing aid use and decreased loneliness (39). However, important limitations to these studies necessitate study of further secondary data analyses in addition to the conduct of rigorously designed randomized controlled trials of hearing remediation for older adults with comorbid hearing loss and syndromal LLD. Studies could be conducted to examine hearing remediation as monotherapy treatment for depression or as an augmentation with antidepressant medications. Importantly, these studies must include comprehensive psychiatric assessments and rigorous methodology including audiometric data and objective documentation of compliance.

These findings must be interpreted in light of several limitations, including our analyses' restriction to subjects without missing data on hearing loss. Subjects (n = 1,871) were not

included if they were missing data on at least one hearing assessment. Included subjects tended to be younger (average age 73.1 vs. 74.0, $p < 0.0001$), better educated (2.31 vs. 2.08, $p < 0.0001$), had fewer medical comorbidities (1.54 vs. 1.80, $p < 0.0001$), had lower mean CES-D scores (4.1 vs. 5.1, $p < 0.0001$), and were more often white (65.9% vs. 54.5% white, $p < 0.0001$). Though included subjects had fewer medical comorbidities and had lower CES-D scores than those who were excluded, we found no significant differences in baseline medical comorbidity or mean CES-D scores between individuals with or without hearing loss among the 1,204 included subjects. There were significant demographic differences between the hearing categories in the included sample, as the hearing impaired category was older, and more likely to be white and male. However, these variations were largely minor and did not fully account for the relationship between hearing loss and depression. In addition, while the standard 20-item CES-D and abbreviated 10CES-D are screening instruments for depressive symptoms (rather than clinical interviews), individuals with the 20-item CES-D ≥ 10 have been repeatedly shown to constitute a cohort at risk for poor outcomes (27–28), and the cutpoint on the abbreviated 10CES-D ≥ 10 has shown good predictive accuracy for clinically significant depressive symptoms (29).

Another limitation was the use of self-reported hearing capacities to evaluate hearing loss. The Health ABC study only performed audiometric evaluations at Year 5, and we felt that it was important to demonstrate a longitudinal association between ARHL and depression. We had concern that this may introduce bias, as stigma around hearing loss may cause individuals not to self-identify as experiencing impairment. However, unlike previous studies, we did corroborate the self-report data with information on peripheral hearing capacity through audiometric testing and validated that the self-report categories and audiometric data correlated highly.

These limitations are offset by the strengths of our analysis, which included the use of a large community dwelling cohort of older adults. By stratifying subjects into increasing- and high-probability of depression trajectories, we were able to differentiate individuals with incident depressive symptoms from those with stable depressive symptoms over time. Another strength of the paper was the use of longitudinal hearing and depression trajectories as opposed to static “baseline-predicts-outcome” methodologies, which have even greater limitations when investigating depression and hearing which change over time with increasing age.

In summary, the finding of an association between ARHL and depressive symptoms suggests that hearing loss may place older adults at risk for developing significant depressive symptoms. Future studies should investigate whether treatment of ARHL may be an effective prevention and/or therapeutic strategy for depressive symptoms. Should studies replicate these results and ARHL proves to be a modifiable risk factor for LLD, increasing its treatment rate (e.g., with hearing aids and cochlear implants) could be one of the most effective strategies for risk reduction given its near-universal prevalence in the elderly and low treatment levels. ARHL and LLD, both individually and together, are responsible for tremendous public health costs, including extensive disability, morbidity, and mortality. This could suggest a novel therapeutic strategy for LLD and thereby mitigate its public health

burden, while also contributing to the increased recognition and treatment of ARHL more generally.

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References

1. Collins JG. Prevalence of selected chronic conditions: United States 1990–1992. Vital Health Statist. 1997; 194:1–89.
2. Kamil RJ, Betz J, Powers BB, et al. Association of Hearing Impairment with Incident Frailty and Falls in Older Adults. J Aging Health. 2016; 28:644–660. [PubMed: 26438083]
3. Lin FR, Chien WW, Li L, et al. Cochlear Implantation in Older Adults. Medicine. 2012; 91:229–241. [PubMed: 22932787]
4. Goman AM, Lin FR. Prevalence of Hearing Loss by Severity in the United States. Am J Public Health. 2016; 106(10):1820–2. [PubMed: 27552261]
5. Cooper JC, Gates GA. Hearing in the elderly—the Framingham cohort, 1983–1985: Part II. Prevalence of central auditory processing disorders. Ear Hear. 1991; 12(5):304–11. [PubMed: 1783233]
6. Agrawal Y, Platz EA, Niparko JK. Prevalence of hearing loss and differences by demographic characteristics among US adults: data from the National Health and Nutrition Examination Survey, 1999–2004. Arch Intern Med. 2008; 168:1522–1530. [PubMed: 18663164]
7. Lin FR, Metter EJ, O'Brien RJ, et al. Hearing loss and incident dementia. Arch Neurol. 2011; 68:214–220. [PubMed: 21320988]
8. Lin FR, Yaffe K, Xia J, et al. Hearing Loss and Cognitive Decline Among Older Adults. JAMA Intern Med. 2013; 173:293–9. [PubMed: 23337978]
9. Cacciatore F, Napoli C, Abete P, et al. Quality of Life Determinants and Hearing Function in an Elderly Population: Osservatorio Geriatrico Campano Study Group. Gerontology. 1999; 45:323–328. [PubMed: 10559650]
10. Abrams TE, Barnett MJ, Hoth A, et al. The relationship between hearing impairment and depression in older veterans. J Am Geriatr Soc. 2006; 54:1475–1477. [PubMed: 16970669]
11. Lee AT, Tong MC, Yuen KC, et al. Hearing Impairment and depressive symptoms in an older Chinese population. J Otolaryngol Head Neck Surg. 2010; 39:498–503. [PubMed: 20828511]
12. Huang CQ, Dong BR, Lu ZC, et al. Chronic diseases and risk for depression in old age: A meta-analysis of published literature. Ageing Res Rev. 2010; 9:131–141. [PubMed: 19524072]
13. Gopinath B, Wang JJ, Schneider J, et al. Depressive symptoms in older adults with hearing impairments: The Blue Mountains Study. J Am Geriatr Soc. 2009; 57:1306–1308. [PubMed: 19570163]
14. Mener DJ, Betz J, Genther DJ, et al. Hearing loss and depression in older adults. J Am Geriatr Soc. 2013; 61:1627–1629. [PubMed: 24028365]
15. Contrera KJ, Betz J, Deal JA, et al. Association of Hearing Impairment and Emotional Vitality in Older Adults. J Gerontol B Psychol Sci Soc Sci. 2016; 71:400–404. [PubMed: 26883806]
16. Choi JS, Betz J, Li L, et al. Association of Using Hearing Aids or Cochlear Implants With Changes in Depressive Symptoms in Older Adults. JAMA Otolaryngol Head Neck Surg. 2016; 142:652–657. [PubMed: 27258813]

17. Poissant SF, Beaudoin F, Huang J, et al. Impact of cochlear implantation on speech understanding, depression, and loneliness in the elderly. J Otolaryngol Head Neck Surg. 2008; 37:488–494. [PubMed: 19128581]
18. Acar B, Yurekli MF, Babademez MA, et al. Effects of hearing aids on cognitive functions and depressive signs in elderly people. Arch Gerontol Geriatr. 2011; 52:250–252. [PubMed: 20472312]
19. Olze H, Szczepek AJ, Haupt H, et al. Cochlear Implantation has a Positive Influence on Quality of Life, Tinnitus, and Psychological Comorbidity. Laryngoscope. 2011; 121:2220–2227. [PubMed: 21898434]
20. Mulrow CD, Aguilar C, Endicott JE, et al. Quality-of-life changes and hearing impairment. A randomized trial. Ann Intern Med. 1990; 113:188–194. [PubMed: 2197909]
21. Knutson JF, Murray KT, Husarek S, et al. Psychological change over 54 months of cochlear implant use. Ear Hear. 1998; 19:191–201. [PubMed: 9657594]
22. Cesari M, Kritchevsky SB, Penninx BW, et al. Prognostic value of usual gait speed in well-functioning older people–results from the Health, Aging and Body Composition Study. J Am Geriatr Soc. 2005; 53:1675–80. [PubMed: 16181165]
23. Newman AB, Haggerty CL, Kritchevsky SB, et al. Walking performance and cardiovascular response: associations with age and morbidity–the Health, Aging and Body Composition Study. J Gerontol A Biol Sci Med Sci. 2003; 58:715–20. [PubMed: 12902529]
24. Deepthi R, Kasthuri A. Validation of the use of self-reported hearing loss and the Hearing Handicap Inventory for elderly among rural Indian elderly population. Arch Gerontol Geriatr. 2012; 55(3):762–7. [PubMed: 22898672]
25. Sorrell JE, Bishop CE, Spankovich C, et al. Relationship of stroke risk and hearing loss in African Americans: The Jackson Heart Study. Laryngoscope. In press.
26. Brown P, Roose SP, Zhang J, et al. Inflammation, depression, and slow gait: A high mortality phenotype in later life. J Gerontol A Biol Sci Med Sci. 2016; 71(2):221–227. [PubMed: 26392405]
27. Meeks TW, Vahia IV, Lavretsky H, et al. A tune in “a minor” can “b major”: a review of epidemiology, illness course, and public health implications of subthreshold depression in older adults. J Affect Disord. 2011; 129(1–3):126–142. [PubMed: 20926139]
28. Brown PJ, Roose SP, Fieo R, et al. Frailty and depression in older adults: a high-risk clinical population. Am J Geriatr Psychiatry. 2014; 22(11):1083–1095. [PubMed: 23973252]
29. Andresen EM, Malmgren JA, Carter WB, et al. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994; 10:77–84. [PubMed: 8037935]
30. Roland, PS., Marple, BF., Meyerhoff, WL., et al. Hearing Loss. New York, NY: Thieme Medical Publishers; 1997.
31. Brink P, Stones M. Examination of the relationship among hearing impairment, linguistic communication, mood, and social engagement of residents in complex continuing-care facilities. Gerontologist. 2007; 47:633–641. [PubMed: 17989405]
32. Mick P, Kawachi I, Lin FR. The association between hearing loss and social isolation in older adults. Otolaryngol Head Neck Surg. 2014; 150:378–384. [PubMed: 24384545]
33. Chia E, Wang JJ, Rochtchina E, et al. Hearing impairment and health related quality of life: the Blue Mountains hearing study. Ear Hear. 2007; 28:187–195. [PubMed: 17496670]
34. Glass TA, De Leon CF, Bassuk SS, et al. Social engagement and depressive symptoms in late life: longitudinal findings. J Aging Health. 2006; 18:604–628. [PubMed: 16835392]
35. Sacco G, Gonfrier S, Teboul B, et al. Clinical evaluation of an over-the-counter hearing aid (TEO First®) in elderly patients suffering of mild to moderate hearing loss. BMC Geriatrics. 2016; 16:136. [PubMed: 27392722]
36. Chien W, Lin FR. Prevalence of hearing aid use among older adults in the United States. Arch Intern Med. 2012; 172(3):292–293. [PubMed: 22332170]
37. Laplante-Lévesque A, Nielsen C, Jensen LD, et al. Patterns of hearing aid usage predict hearing aid use amount (data logged and self-reported) and overreport. J Am Acad Audiol. 2014; 25(2):187–98. [PubMed: 24828219]

38. Solheim J, Hickson L. Hearing aid use in the elderly as measured by datalogging and self-report. Int J Audiol. 2017; 56(7):472–479. [PubMed: 28332420]

39. Contrera KJ, Sung YK, Betz J, et al. Change in loneliness after intervention with cochlear implants or hearing aids. Laryngoscope. 2017; 127(8):1885–1889. [PubMed: 28059448]

Highlights

- Recently, age-related hearing loss (ARHL) has been associated with late-life depression, however the existing data is mixed and preliminary.
- Using data from the Health ABC study, ARHL was found to be associated both cross-sectionally and longitudinally with increased depressive symptoms in otherwise healthy older adults followed over 10-years.
- This study contributes to the theory that ARHL may place older adults at risk for developing depressive symptoms
- Future studies should investigate whether treatment of ARHL may be an effective prevention and/or therapeutic strategy for depressive symptoms.

Table 1

Baseline Characteristics for the Sample and Hearing Category over 10 years from the Health Aging and Body Composition Study

Characteristic	Total Sample (n = 1,204)		Hearing Impairment (n = 182)		No Hearing Impairment (n = 1,022)		
	N	Mean (SD) or %	N	Mean (SD) or %	N	Mean (SD) or %	P-value
Demographic							
Age, y	1204	73.1 (2.75)	182	73.7 (2.94)	1022	73 (2.71)	0.002
Educational level	1202	2.31 (0.77)	182	2.34 (0.82)	1020	2.3 (0.76)	0.5759
Sex, No. M/F (%M)	1204	46.01%	182	62.09%	1022	43.15%	<.0001
Body mass index	1204	27.4 (4.53)	182	27.2 (4.3)	1022	27.5 (4.57)	0.37
White/black (%white)	1204	65.86%	182	74.73%	1022	64.29%	0.0062
3MS total score	1203	92.2 (6.86)	181	92.1 (6.77)	1022	92.3 (6.88)	0.703
Medical comorbidities	1093	1.54 (1.03)	162	1.67 (1.03)	931	1.52 (1.02)	0.0869
Depression scores							
CES-D	1194	4.1 (4.86)	180	4.4 (4.64)	1014	4.1 (4.89)	0.3779
(% ≥ 10)	1194	11.47%	180	11.11%	1014	11.54%	0. 8683

Notes: Hearing Impairment defined as Impaired/Worsening self-reported hearing over 10 years, No Hearing Impairment defined as Healthy/Improving self-reported hearing over 10 years; Education defined as 1 = less than high school, 2 = high school graduation, 3 = post secondary education; 3MS = Modified Mini-Mental Status Exam; Medical comorbidities defined as number of vascular, physical, respiratory, cardiovascular, cerebrovascular diseases and cancer malignant; CES-D = 20-item Center for Epidemiologic Studies Depression Scale; Clinically significant depression symptoms defined as CES-D ≥ 10.

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Table 2

Association between Audiometric Hearing and Depression at Year 5

			Continuous 10CESD*		Depression (10CESD*) Category			
			(N=1204)		≥ 10 (N=503)	<10 (N=701)		
	N (both ears)	N (one ear)	Partial r	P-value	Mean (SD)	Mean (SD)	Adjusted Mean Difference	P-value
Low-Frequency								
250 Hz	1181	3	0.11	0.0002	26.40 (11.18)	24.02 (9.95)	2.29	0.0005
Mid-Frequency								
500 Hz	1181	2	0.10	0.0010	24.92 (13.33)	22.65 (11.54)	2.28	0.0030
1000 Hz	1181	6	0.07	0.0146	26.41 (14.94)	24.50 (13.56)	2.05	0.0195
2000 Hz	1181	6	0.07	0.0302	33.90 (17.71)	32.79 (17.23)	2.51	0.0169
Combined 500-2000 Hz	1181		0.09	0.0042	28.41 (13.98)	26.65 (12.57)	2.28	0.0049
High-Frequency								
4000 Hz	1177	13	0.03	0.3013	45.79 (19.54)	47.42 (19.65)	1.09	0.3029
8000 Hz	1151	88	0.03	0.3493	64.66 (18.08)	65.45 (17.64)	1.16	0.2724
Combined 4000-8000 Hz	1178		0.04	0.2381	55.37 (17.09)	56.56 (16.92)	1.15	0.2208

Note: partial r, adjusted mean difference (10CESD ≥ 10 vs. 10CESD < 10), and p-values are adjusted for age, gender, race and medical comorbidities

*10-item Center for Epidemiologic Studies Depression Scale