SUPPLEMENTARY MATERIAL

Table S1. MOOSE checklist for meta-analyses of observational studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	3
2	Hypothesis statement	7
3	Description of any outcome(s)	7,8
4	Type of exposure or intervention used	7,8
5	Type of study designs used	7,8
6	Study population	7,8
Reporting of search strategy should include		
7	Qualifications of searchers (e.g., librarians and investigators)	8
8	Search strategy, including time period included in the synthesis and key words	7
9	Effort to include all available studies, including contact with authors	8
10	Databases and registries searched	7
11	Search software used, name and version, including special features used (e.g., explosion)	9
12	Use of hand searching (e.g., reference lists of obtained articles)	7
13	List of citations located and those excluded, including justification	10,11
14	Method of addressing articles published in languages other than English	7
15	Method of handling abstracts and unpublished studies	7
16	Description of any contact with authors	8
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	10,11
18	Rationale for the selection and coding of data (e.g., sound clinical principles or convenience)	8
19	Documentation of how data were classified and coded (e.g., multiple raters, blinding and interrater reliability)	7,8
20	Assessment of confounding (e.g., comparability of cases and controls in studies where appropriate)	8
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	8,9
22	Assessment of heterogeneity	9,10
23	Description of statistical methods (e.g., complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	9,10
24	Provision of appropriate tables and graphics	10,11,12,13
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	11
26	Table giving descriptive information for each study included	10
27	Results of sensitivity testing (e.g., subgroup analysis)	13

28	Indication of statistical uncertainty of findings	11,12,13
Reporting of discussion should include		
29	Quantitative assessment of bias (e.g., publication bias)	11,12
30	Justification for exclusion (e.g., exclusion of non-English language citations)	–
31	Assessment of quality of studies	13,14,15,16,17
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	14,15
33	Generalization of the conclusions (i.e., appropriate for the data presented and within the domain of the literature review)	19,20,21
34	Guidelines for future research	19,20,21
35	Disclosure of funding source	22

Source: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. JAMA, 2000, 283: 2008-2012. doi:10.1001/jama.283.15.2008.

Table S2. Example of search terms and strategy

Database	Search parameters
MEDLINE	(Hearing* OR Cochlear*) AND (Older adult* OR Elderly*) AND (Depression OR Mental health OR Mental illness OR Personality disorder)
	Date range: First date of publication to July 17, 2018
	Limited to English language and human participants

Table S3. Included studies grouped by characteristics

Used an objective measure of hearing loss	
	Herbst et al. (1980), Hidalgo et al. (2009), Jang et al. (2003), Kiely et al. (2013), Mick et al. (2016)
Used a subjective measure of hearing loss	
	Amieva et al. (2018), Bazargan et al. (2001), Behera et al. (2016), Bergdahl et al. (2005), Blay et al. (2007), Boorsma et al. (2012), Brewster et al. (2018), Carabellese et al. (1993), Chou et al. (2005), Chou et al. (2008), Cosh et al. (2017), Crews et al. (2004), Forsell (2000), Jones et al. (1984), Krsteska, 2012, Lee et al. (2016), Lindesey (1990), Malhotra et al. (2010), Millan-Calenti et al. (2011), Ojagbemi et al. (2016), Perlmutter et al. (2010), Prince et al. (1998), Rosso et al. (2013), Saito et al. (2010), Simning et al. (2018), Yasuda et al. (2007)
Used objective and subjective measures of hearing loss	
	Al Sabahi et al. (2014), Keidser et al. (2017), Lee et al. (2010), Pronk et al. (2011)
Included participants with experience using hearing aids	
	Amieva et al. (2018), Bergdahl et al. (2005), Boorsma et al. (2012), Brewster et al. (2018), Herbst et al. (1980), Hidalgo et al. (2009), Jones et al. (1984), Kiely et al. (2013), Lee et al. (2010), Pronk et al. (2011), Saito et al. (2010), Simning et al. (2018)
Included a proportion of participants with cognitive decline	
	Al Sabahi et al. (2014), Amieva et al. (2018), Bazargan et al. (2001), Bergdahl et al. (2005), Boorsma et al. (2012), Carabellese et al. (1993), Chou et al. (2005), Forsell (2000), Hidalgo et al. (2009), Jang et al. (2003), Jones et al. (1984), Kiely et al. (2013), Lee et al. (2016), Lindesey (1990), Ojagbemi et al. (2016), Perlmutter et al. (2010), Prince et al. (1998), Yasuda et al. (2007)
Controlled for covariates in outcome results	
	Amieva et al. (2018), Behera et al. (2016), Blay et al. (2007), Brewster et al. (2018), Chou (2008), Cosh et al. (2017), Crews et al. (2004), Jang et al. (2003), Kiely et al. (2013), Lee et al. (2010), Lee et al. (2016), Malhotra et al. (2010), Mick et al. (2016), Prince et al. (1998), Pronk et al. (2011), Saito et al. (2010)

Table S4. Complete reference list of included studies

Cross-sectional studies

Al Sabahi, S., Al Sinawi, H., Al Hinai, S., & Youssef, R. (2014). Rate and correlates of depression among elderly people attending primary health care centres in Al Dakhiliyah governorate, Oman. *Eastern Mediterranean Health Journal,* 20, 181-189

Bazargan, M., Bazargan, S., & King, L. (2001). Paranoid ideation among elderly African American persons. *The Gerontologist,* 41, 366-373. doi:10.1093/geront/41.3.366

Behera, P., Sharan, P., Mishra, A. K., Nongkynrih, B., Kant, S., & Gupta, S. K. (2016). Prevalence and determinants of depression among elderly persons in a rural community from northern India. *The National Medical Journal of India,* 29, 129-136

Bergdahl, E., Gustavsson, J. M., Kallin, K., von Heideken Wågert, P., Lundman, B., Bucht, G., & Gustafson, Y. (2005). Depression among the oldest old: the Umeå 85+ study. *International Psychogeriatrics,* 17, 557-575. doi:10.1017/S1041610205002267

Blay, S. L., Andreoli, S. B., Fillenbaum, G. G., & Gastal, F. L. (2007). Depression morbidity in later life: Prevalence and correlates in a developing country. *The American Journal of Geriatric Psychiatry,* 15, 790-799. doi:10.1097/JGP.0b013e3180654179

Carabellese, C., Appollonio, I., Rozzini, R., Bianchetti, A., Frisoni, G. B., Frattola, L., & Trabucchi, M. (1993). Sensory impairment and quality of life in a community elderly population. *J Am Geriatr Soc,* 41, 401-407. doi:10.1111/j.1532-5415.1993.tb06948.x

Chou, K. L., & Chi, I. (2005). Prevalence and correlates of depression in Chinese oldest-old. *International Journal of Geriatric Psychiatry,* 20, 41-50. doi:10.1002/gps.1246

Crews, J. E., & Campbell, V. A. (2004). Vision impairment and hearing loss among community-dwelling older Americans: Implications for health and functioning. *American Journal of Public Health,* 94, 823-829. doi:10.2105/AJPH.94.5.823

Herbst, K. G., & Humphrey, C. (1980). Hearing impairment and mental state in the elderly living at home. *The British Medical Journal,* 281, 903-905. doi:10.1136/bmj.281.6245.903

Hidalgo, J. L.-T., Gras, C. B., Lapeira, J. T., Verdejo, M. Á. L., del Campo, J. M. d. C., & Rabadán, F. E. (2009). Functional status of elderly people with hearing loss. *Archives of Gerontology and Geriatrics,* 49, 88-92. doi:10.1016/j.archger.2008.05.006

Jang, Y., Mortimer, J. A., Haley, W. E., Small, B. J., Chisolm, T. E. H., & Graves, A. B. (2003). The role of vision and hearing in physical, social, and emotional functioning among older adults. *Research on Aging,* 25, 172-191. doi:10.1177/0164027502250019

Jones, D. A., Victor, C. R., & Vetter, N. J. (1984). Hearing difficulty and its psychological implications for the elderly. *Journal of Epidemiology & Community Health,* 38, 75-78. doi:10.1136/jech.38.1.75

Keidser, G., & Seeto, M. (2017). The influence of social interaction and physical health on the association between hearing and depression with age and gender. *Trends in Hearing,* 21, 1-15. doi:10.1177/2331216517706395

Krsteska, R. (2012). Hearing and visual impairments as risk factors for late-life depression. *Journal of Special Education and Rehabilitation,* 13, 46-59. doi:10.2478/v10215-011-0018-2

Lee, A. T., Tong, M. C., Yuen, K. C., Tang, P. S., & Hasselt, C. (2010). Hearing impairment and depressive symptoms in an older Chinese population. *Journal of Otolaryngology--Head & Neck Surgery,* 39. doi:10.2310/7070.2010.090265

Lee, S., & Hong, G.-R. S. (2016). Predictors of depression among community-dwelling older women living alone in Korea. *Archives of Psychiatric Nursing,* 30, 513-520. doi:10.1016/j.apnu.2016.05.002

Lindesay, J. (1990). The Guy's/Age Concern Survey: physical health and psychiatric disorder in an urban elderly community. *International Journal of Geriatric Psychiatry,* 5, 171-178. doi:10.1002/gps.930050305

Malhotra, R., Chan, A., & Østbye, T. (2010). Prevalence and correlates of clinically significant depressive symptoms among elderly people in Sri Lanka: Findings from a national survey. *International Psychogeriatrics,* 22, 227-236. doi:10.1017/S1041610209990871

Mick, P., & Pichora-Fuller, M. K. (2016). Is hearing loss associated with poorer health in older adults who might benefit from hearing screening? *Ear & Hearing,* 37, e194-e201. doi:10.1097/AUD.0000000000000267

Millán-Calenti, J. C., Maseda, A., Rochette, S., Vázquez, G. A., Sánchez, A., & Lorenzo, T. (2011). Mental and psychological conditions, medical comorbidity and functional limitation: Differential associations in older adults with cognitive impairment, depressive symptoms and co-existence of both. *International Journal of Geriatric Psychiatry,* 26, 1071-1079. doi:10.1002/gps.2646

Ojagbemi, A., Bello, T., Luo, Z., & Gureje, O. (2016). Chronic conditions, new onset, and persistent disability in the Ibadan Study of Aging. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences,* 72, 997-1005. doi:10.1093/gerona/glv188

Perlmutter, M. S., Bhorade, A., Gordon, M., Hollingsworth, H. H., & Baum, M. C. (2010). Cognitive, visual, auditory, and emotional factors that affect participation in older adults. *American Journal of Occupational Therapy,* 64, 570-579. doi:10.5014/ajot.2010.09089

Rosso, A. L., Eaton, C. B., Wallace, R., Gold, R., Stefanick, M. L., Ockene, J. K., . . . Michael, Y. L. (2013). Geriatric syndromes and incident disability in older women: Results from the women's health initiative observational study. *Journal of the American Geriatric Society,* 61, 371-379. doi:10.1111/jgs.12147

Yasuda, M., Horie, S., Albert, S. M., & Simone, B. (2007). The prevalence of depressive symptoms and other variables among frail aging men in New York City's Personal Care Services program. *The Journal of Men's Health & Gender,* 4, 165-170. doi:10.1016/j.jmhg.2007.02.006

Cohort studies

Amieva, H., Ouvrard, C., Meillon, C., Rullier, L., & Dartigues, J.-F. (2018). Death, Depression, Disability and Dementia Associated with Self-Reported Hearing Problems: A 25-Year Study. *The Journals of Gerontology: Series A,* In press. doi:10.1093/gerona/glx250

Boorsma, M., Joling, K., Dussel, M., Ribbe, M., Frijters, D., van Marwijk, H. W., . . . van Hout, H. (2012). The incidence of depression and its risk factors in Dutch nursing homes and residential care homes. *The American Journal of Geriatric Psychiatry,* 20, 932-942. doi:10.1097/JGP.0b013e31825d08ac

Brewster, K. K., Ciarleglio, A., Brown, P. J., Chen, C., Kim, H.-O., Roose, S. P., . . . Rutherford, B. R. (2018). Age-Related Hearing Loss and Its Association with Depression in Later Life. *The American Journal of Geriatric Psychiatry,* In press. doi:10.1016/j.jagp.2018.04.003

Chou, K. L. (2008). Combined effect of vision and hearing impairment on depression in older adults: Evidence from the English Longitudinal Study of Ageing. *Journal of Affective Disorders,* 106, 191-196. doi:10.1016/j.jad.2007.05.028

Cosh, S., Hanno, T., Helmer, C., Bertelsen, G., Delcourt, C., & Schirmer, H. (2017). The association amongst visual, hearing, and dual sensory loss with depression and anxiety over 6 years: The Tromsø Study. *International Journal of Geriatric Psychiatry*, 1-8. doi:10.1002/gps.4827

Forsell, Y. (2000). Predictors for depression, anxiety and psychotic symptoms in a very elderly population: Data from a 3-year follow-up study. *Social Psychiatry and Psychiatric Epidemiology,* 35, 259-263. doi:10.1007/s001270050237

Kiely, K. M., Anstey, K. J., & Luszcz, M. A. (2013). Dual sensory loss and depressive symptoms: The importance of hearing, daily functioning, and activity engagement. *Frontiers in Human Neuroscience,* 7, 1-13. doi:10.3389/fnhum.2013.00837

Prince, M. J., Harwood, R. H., Thomas, A., & Mann, A. H. (1998). A prospective population-based cohort study of the effects of disablement and social milieu on the onset and maintenance of late-life depression. The Gospel Oak Project VII. *Psychological Medicine,* 28, 337-350.

Pronk, M., Deeg, D. J., Smits, C., Tilburg, T. G. v., Kuik, D. J., Festen, J. M., & Kramer, S. E. (2011). Prospective effects of hearing status on loneliness and depression in older persons: Identification of subgroups. *International Journal of Audiology,* 50, 887-896. doi:10.3109/14992027.2011.599871

Saito, H., Nishiwaki, Y., Michikawa, T., Kikuchi, Y., Mizutari, K., Takebayashi, T., & Ogawa, K. (2010). Hearing handicap predicts the development of depressive symptoms after 3 years in older community-dwelling Japanese. *Journal of the American Geriatric Society,* 58, 93-97. doi:10.1111/j.1532-5415.2009.02615.x

Simning, A., Fox, M. L., Barnett, S. L., Sorensen, S., & Conwell, Y. (2018). Depressive and anxiety symptoms in older adults with auditory, vision, and dual sensory impairment. *Journal of Aging and Health,* In press. doi:10.1177/0898264318781123

Table S5. Moderator analysis of heterogeneity

		Effect size statistics						Between groups Q-test of variance	
				95% CI					
Moderator	Subgroup	*k*	OR	Lower	Upper	Z	*p*	Q (df)	*p*
Hearing measure	Objective (PTA, SIN)	6	1.56	1.20	2.03	3.31	.001*	.61 (1)	.44
	Subjective (self-report)	32	1.39	1.22	1.58	4.96	.001**		
Hearing aids	Some participants used hearing aids	15	1.47	1.23	1.77	4.19	.001**	.004 (1)	.95
	No participants used hearing aids	27	1.46	1.25	1.71	4.83	.001**		
Cognitive impairment	Some participants had cognitive impairment	21	1.53	1.29	1.81	4.85	.001**	.42 (1)	.52
	No participants had cognitive impairment	21	1.42	1.22	1.65	4.46	.001**		
Covariates	Controlled by studies	18	1.45	1.22	1.71	4.26	.001**	.07 (1)	.79
	Not controlled by studies	24	1.49	1.26	1.77	4.58	.001**		

Abbreviations: *k* = Number of studies/subgroups included in pooled effect; OR = Odds ratio; CI = Confidence interval; *p* = Significance level; Q = Cochrane's Q; PTA = Pure-tone audiometry; SIN = Speech-in-noise test; * *p* = .001; ** = *p* < .001

Table S6. Sensitivity analyses

				Effect size statistics					Heterogeneity statistics		
					95% CI						
Outcome	Studies removed	Reason		OR	Lower	Upper	Z	*p*	Q (df)	*p*	I^2
Depression			Original pooled effect	1.47	1.31	1.65	6.47	.001**	244.98 (41)	.001**	83.26
	Cosh et al. (2017) Jang et al. (2003) Keidser et al. (2017) Kiely et al. (2013) Pronk et al. (2011)	OR's converted from β	Changed pooled effect	1.41	1.26	1.58	5.97	.001**	130.58 (34)	.001**	73.96
	Keidser et al. (2017) Rosso et al. (2013)	Large *N*	Changed pooled effect	1.45	1.27	1.65	5.54	.001**	238.18 (38)	.001**	84.05
	Boorsma et al. (2012) Krteska (2012) Yasuda et al. (2007)	High care settings	Changed pooled effect	1.49	1.32	1.67	6.62	.001**	213.20 (37)	.001**	82.65

Abbreviations: OR = Odds ratio; CI = Confidence Interval; *p* = significance level; Q = Cochrane's Q. ** = $p < .001$; β = Beta coefficient.