JAMA | US Preventive Services Task Force | EVIDENCE REPORT

Screening for Hearing Loss in Older Adults
Updated Evidence Report and Systematic Review for the US Preventive Services Task Force

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IMPORTANCE Hearing loss is common in older adults and associated with adverse health and social outcomes.

OBJECTIVE To update the evidence review on screening for hearing loss in adults 50 years or older to inform the US Preventive Services Task Force.

DATA SOURCES MEDLINE, Cochrane Library, EMBASE, and trial registries through January 17, 2020; references; and experts; literature surveillance through October 8, 2020.

STUDY SELECTION English-language studies of accuracy, screening, and interventions for screen-detected or newly detected hearing loss.

DATA EXTRACTION AND SYNTHESIS Dual review of abstracts, full-text articles, and study quality. Meta-analysis of screening test accuracy studies.

MAIN OUTCOMES AND MEASURES Quality of life and function, other health and social outcomes, test accuracy, and harms.

RESULTS Forty-one studies (N = 26 386) were included, 18 of which were new since the previous review. One trial enrolling US veterans (n = 2305) assessed the benefits of screening; there was no significant difference in the proportion of participants experiencing a minimum clinically important difference in hearing-related function at 1 year (36%-40% in the screened groups vs 36% in the nonscreened group). Thirty-four studies (n = 23 228) evaluated test accuracy. For detecting mild hearing loss (>20-25 dB), single-question screening had a pooled sensitivity of 66% (95% CI, 58%-73%) and a pooled specificity of 76% (95% CI, 68%-83%) (10 studies, n = 12 637); for detecting moderate hearing loss (>35-40 dB), pooled sensitivity was 80% (95% CI, 68%-88%) and pooled specificity was 74% (95% CI, 59%-85%) (6 studies, n = 8774). In 5 studies (n = 2820) on the Hearing Handicap Inventory for the Elderly–Screening to detect moderate hearing loss (>40 dB), pooled sensitivity was 68% (95% CI, 52%-81%) and pooled specificity was 78% (95% CI, 67%-86%). Six trials (n = 853) evaluated amplification vs control in populations with screen-detected or recently detected hearing loss over 6 weeks to 4 months. Five measured hearing-related function via the Hearing Handicap Inventory for the Elderly; only 3 that enrolled veterans (n = 684) found a significant difference considered to represent a minimal important difference (>18.7 points). Few trials reported on other eligible outcomes, and no studies reported on harms of screening or interventions.

CONCLUSIONS AND RELEVANCE Several screening tests can adequately detect hearing loss in older adults; no studies reported on the harms of screening or treatment. Evidence showing benefit from hearing aids on hearing-related function among adults with screen-detected or newly detected hearing loss is limited to studies enrolling veterans.

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Age-related hearing loss, the most common cause of hearing loss in older adults, is a type of sensorineural hearing loss related to age-related degeneration. It is typically gradual, progressive, and bilateral and affects higher hearing frequencies first.[1] Pure-tone audiometry is the standard objective test for hearing loss and tests the ability to hear tones at a series of discrete frequencies, typically in the range of 250 to 8000 Hz, at various decibel levels. There is no universally accepted definition for hearing loss, although many guidelines define mild hearing loss as the inability to detect frequencies associated with speech understanding under 25 dB and moderate hearing loss as the inability to detect those frequencies under 40 dB. There is often discordance between objectively measured hearing loss on pure-tone audiometry and subjective perceptions of hearing problems.[2,3]

The prevalence of mild or worse speech-frequency hearing loss is estimated to be 14.1% among adults aged 20 to 65 years and increases significantly with age, up to 39.3% for adults aged 60 to 69 years.[4] Observational studies indicate that hearing loss is associated with higher rates of incident disability and need for nursing care, social isolation, depressive symptoms, and cognitive decline or dementia.[5-8]

Use of hearing aids is the primary intervention for persons with newly detected mild or moderate hearing loss. Hearing aid use does not slow progression of hearing loss; the goal is to amplify sound reaching the middle or inner ear to improve communication and function associated with hearing impairment. In 2012, the US Preventive Services Task Force (USPSTF) concluded that evidence was insufficient to assess the balance of benefits and harms of screening for hearing loss in asymptomatic adults 50 years or older (I statement).[9] This updated review evaluates the current evidence on screening for hearing loss for populations and settings relevant to primary care in the US to inform an updated recommendation by the USPSTF.

Methods

Scope of the Review

Detailed methods are available in the full evidence report.[10] **Figure 1** shows the analytic framework and key questions (KQs) that guided the review.

Data Sources and Searches

PubMed/MEDLINE, the Cochrane Library, EMBASE, and ClinicalTrials.gov were searched for English-language articles from 2010 through January 17, 2020 (eMethods in the Supplement). Studies published before 2010 were identified from the prior systematic review for the USPSTF.[12] To supplement searches, investigators reviewed reference lists of pertinent articles suggested by peer reviewers and public comment respondents. Since January 2020, ongoing surveillance was conducted through article alerts and targeted searches of journals to identify major studies published in the interim that may affect the conclusions or understanding of the evidence and the related USPSTF recommendation. Two studies of screening test accuracy were identified by ongoing surveillance (last conducted on October 8, 2020). One evaluated the Hearing Handicap Inventory for the Elderly–Screening (HHIE-S) and single-question screening,[13] and the second evaluated a tablet-based pure-tone screening test and a word-in-noise test.[14] Findings were similar to those reported by other studies of similar screening tests included in this review and did not change conclusions or the strength of evidence.

Study Selection

Two investigators independently reviewed titles, abstracts, and full-text articles using prespecified eligibility criteria (eMethods in the Supplement). Disagreements were resolved by discussion and consensus. English-language studies of adults 50 years or older conducted in settings generalizable to primary care and in countries categorized as "very high" on the United Nations Human Development Index were included.[15] The age criterion was chosen because of a higher prevalence of age-related hearing loss in persons older than 50 years (compared with younger adults) and is consistent with the prior review for the USPSTF.

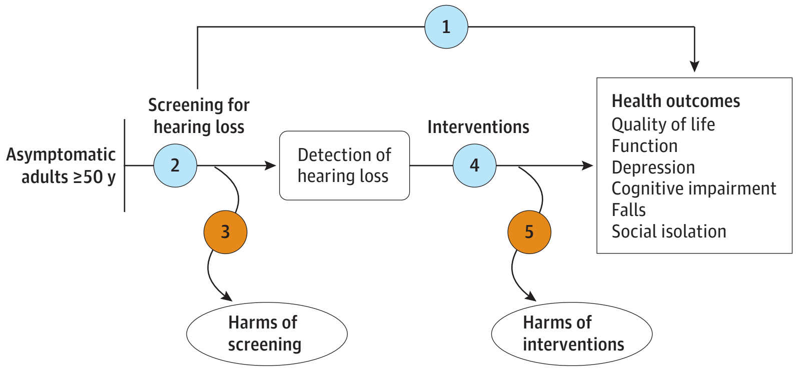
For KQ1 and KQ3 (direct evidence of benefits and harms of screening), randomized clinical trials (RCTs), nonrandomized controlled intervention studies, and cohort studies enrolling adults with asymptomatic or undetected hearing loss and comparing screening with no screening were eligible. For KQ2 (test accuracy), studies of asymptomatic or unselected older adults comparing 1 or more screening tests with diagnostic pure-tone audiometry were included. For KQs1 through 3, eligible screening tests included those used, available, or feasible for use in primary care settings (eTable 1 in the Supplement).

For KQs on benefits (KQ4) and harms (KQ5) of amplification, RCTs, nonrandomized controlled intervention studies, and cohort studies of adults with screen-detected or newly detected sensorineural hearing loss were included. Eligible studies compared amplification using any type of hearing aid, personal assistive listening devices, or personal sound amplification device (with or without additional education or counseling) with a no-amplification control group (no treatment, wait-list, or placebo amplification device). Eligible outcomes for KQs on the benefit of screening and treatment (KQ1 and KQ4) include measures of hearing-related quality of life (QOL) or function, general health-related QOL and function, depression, cognitive impairment, falls, and social isolation.

Data Extraction and Quality Assessment

For each study, 1 investigator extracted information about populations, tests or interventions, comparators, outcomes, settings, and designs, and a second investigator reviewed for completeness and accuracy. Two independent investigators assessed the quality of each study as good, fair, or poor. For RCTs, the most recent versions of the Cochrane Risk of Bias Tool available for parallel[16] and crossover trials were used.[17] For nonrandomized controlled intervention studies, the ROBINS-I tool was used.[18] For studies of diagnostic test accuracy, the QUADAS-2 instrument was used.[19] Risk-of-bias assessments using these instruments were translated into an overall study quality rating of good, fair, or poor using predefined criteria developed by the USPSTF and adapted for this topic (eMethods in the Supplement).[11] Only studies rated as good or fair quality were included. Individual study

Figure 1. Analytic Framework and Key Questions: Screening for Hearing Loss in Older Adults



Key questions

1. a. Does screening for hearing loss in asymptomatic adults 50 years or older lead to improved health outcomes?
   b. Does the effectiveness of screening differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbidity?

2. What is the accuracy of primary care-relevant screening tests for hearing loss in adults 50 years or older?

3. a. What are the harms of screening for hearing loss in adults 50 years or older?
   b. Do the harms of screening for hearing loss differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbid condition?

4. a. What is the efficacy or interventions for screen-detected hearing loss in improving health outcomes in adults 50 years or older?
   b. Does the efficacy of interventions for screen-detected hearing loss differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbid condition?

5. a. What are the harms of interventions for screen-detected hearing loss in adults 50 years or older?
   b. Do the harms of interventions for screen-detected hearing loss differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbid condition?

Evidence reviews for the US Preventive Services Task Force (USPSTF) use an analytic framework to visually display the key questions that the review will address to allow the USPSTF to evaluate the effectiveness and harms of a preventive service. The questions are depicted by linkages that relate interventions and outcomes. Additional details are provided in the USPSTF Procedure Manual.[11]

quality ratings are provided in eTables 2-12 and eTables 14-17 in the Supplement.

Data Synthesis and Analysis

Findings for each question were summarized in tables, figures, and narrative format. For KQ2, pooled sensitivities and specificities for screening tests were calculated using a hierarchical summary receiver operating characteristic curve analysis when at least 4 similar studies were available. Results were synthesized by type of screening test, as well as severity of hearing loss (eg, detection of mild vs moderate hearing loss). For studies that reported on multiple definitions of hearing loss, estimates included in pooled analyses were chosen based on similarity in decibel level, frequencies included in pure-tone audiometry, and laterality to other included studies. The *metandi* program in Stata version 14 was used to conduct all quantitative analyses.[20]

The overall strength of the body of evidence was assessed for each KQ as high, moderate, low, or insufficient using methods developed for the USPSTF (and the Evidence-based Practice program), based on the overall quality of studies, consistency of results between studies, precision of findings, and risk of reporting bias.[11] The applicability of the findings to US primary care populations and settings was also assessed. Discrepancies were resolved through consensus discussion.

Results

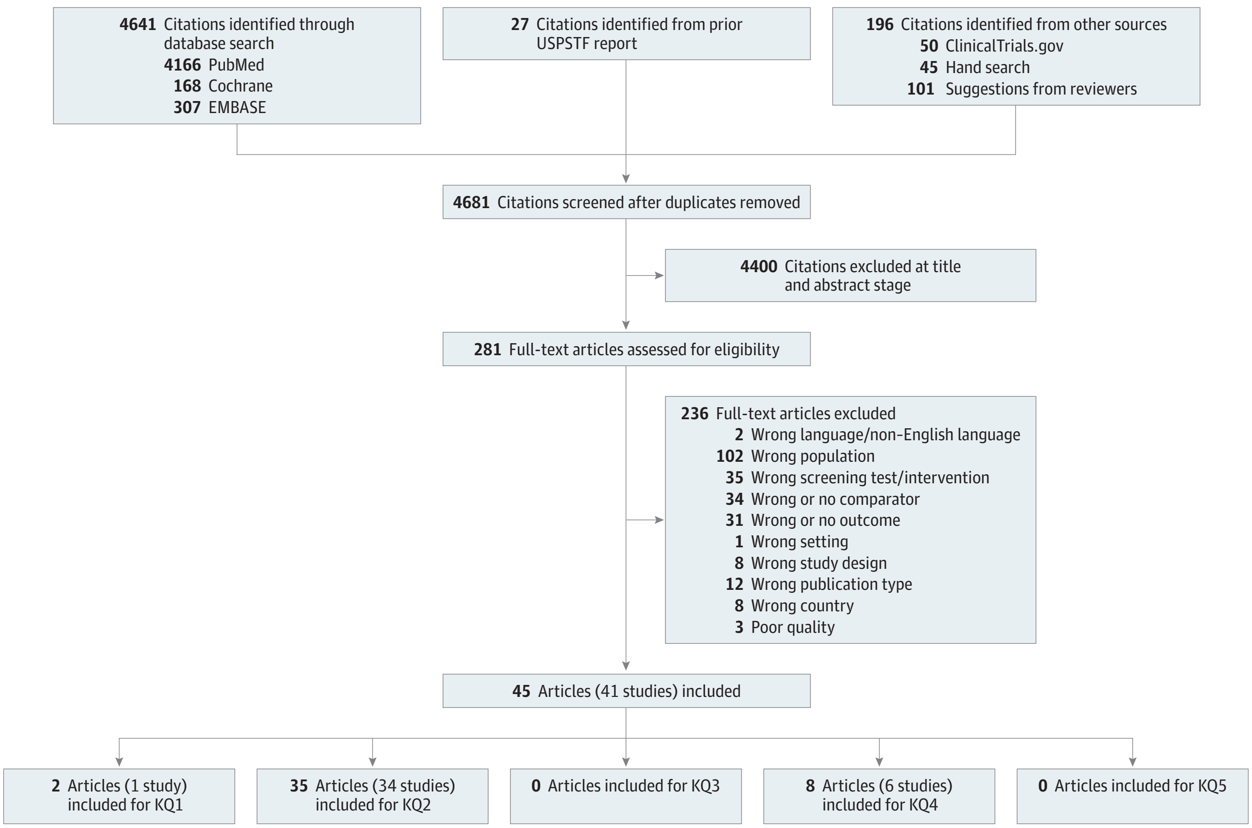
A total of 41 studies (45 articles) with 26 386 participants were included (**Figure 2**). Eighteen studies (20 articles)[21-40] were newly identified in this review, and 23 studies (25 articles)[41-65] were carried forward from the prior review for the USPSTF. Of these, 1 RCT evaluated the benefit of screening, 34 studies assessed test accuracy, and 6 trials evaluated the benefit of treatment among populations with screen-detected or recently detected hearing loss.

Benefits of Screening

Key Question 1A. Does screening for hearing loss in asymptomatic adults 50 years or older lead to improved health outcomes?

One fair-quality RCT included in the prior USPSTF review[12] evaluated screening for hearing loss (n = 2305): the Screening for Auditory Impairment—Which Hearing Assessment Test (SAI-WHAT) trial (eTable 18 in the Supplement).[44,65] Participants were recruited from a VA Medical Center and randomized to usual care (no screening) or 1 of 3 screening approaches: a handheld screening audiometer (based on the inability to hear a 40-dB tone at 2000 Hz in either ear), a screening questionnaire (HHIE-S, based on a score ≥10), or both screening tests. Participants were

Figure 2. Literature Flow Diagram: Screening for Hearing Loss in Older Adults



KQ indicates key question; USPSTF, US Preventive Services Task Force.

predominantly male (94%), 50 years or older (mean, 61 years), and all were eligible to receive free, Veterans Administration–issued hearing aids. The study aimed to compare screening with usual care; however, baseline assessment (before randomization) included an assessment of self-perceived hearing loss; most participants (74%) reported perceived hearing loss at enrollment (based on a "yes" or "maybe" response to the question "Do you think you have hearing loss?"). Participants who screened positive for hearing loss in any of the screening groups were told that they might have hearing loss and were given written instructions to call the audiology clinic for an evaluation. Participants in the nonscreened group were provided with a telephone number for the audiology clinic if they wanted further assessment.

The proportion who screened positive in the groups randomized to screening was lowest in the screening audiometry group (19%) and higher in the HHIE-S group (59%) and combined group (64%). Hearing aid use at 1 year, the trial's primary outcome, was significantly higher among participants in the screening audiometry group and combined group than among those in the nonscreened group (6.3% and 7.4% vs 3.3%, respectively; $P < .01$) but not among participants in the HHIE-S group compared with those in the nonscreened group (4.1% vs 3.3%; $P > .40$).

There was no significant difference in the proportion of participants who experienced a minimum clinically important difference (>6 points of improvement on a 0-100 scale) on the Inner Effectiveness of Aural Rehabilitation scale (a measure of hearing-related function) at 1 year (36%-40% in the screened groups vs 36% in the nonscreened group; $P = .39$).

Key Question 1B. Does the effectiveness of screening differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbidity?

The SAI-WHAT trial conducted post hoc analyses of hearing-related function for subpopulations defined by age.[44,65] There were no significant differences between screened and nonscreened groups in the proportion who experienced improvement on the Inner Effectiveness of Aural Rehabilitation scale when groups were stratified by age (50-64 years vs ≥65 years) and according to whether they had perceived hearing loss at baseline, except in a subgroup that both had perceived hearing loss at baseline and was 65 years or older (54% in the screening audiometry group, 34% in the HHIE-S group, 40% in the combined group, and 34% in the control group; $P = .04$).

Screening Accuracy

Key Question 2. What is the accuracy of primary care–relevant screening tests for hearing loss in adults 50 years or older?

Thirty-four studies (reported in 35 articles) (n = 23 228) evaluated the diagnostic accuracy of clinical tests, a single question, a questionnaire, a handheld audiometric device, or a mobile-based audiometric application for identifying mild to moderate hearing loss in older adults. Some studies assessed the accuracy of multiple screening tests. All studies used pure-tone audiometry as the reference standard, although the thresholds and the criteria used to diagnose hearing loss varied both across and within studies (eTable 19 in the Supplement).

Most studies included community-dwelling older adults enrolled from various outpatient clinical or community settings; 4 studies included adults who were in chronic care/rehabilitation facilities.[53,54,57,62] Across the 28 studies that reported on the age of enrolled participants (mean, median, or range), the median age of participants was 69 years. Most studies (17) were set in the US[25,26,38,41,46,47,50-52,54-56,58,59,61-64]; others were set in Canada,[23,53] the UK,[33,57,60] Australia,[21,49] various European countries,[22,24,27,29,30,39,40,48] and Asia.[28,34] Six studies were rated as good quality[21,23,39,50,59,64] and the remainder as fair quality.

Table 1 provides a summary of accuracy data by screening test, and eTables 20-23 in the Supplement present detailed evidence tables for each screening test type. For detecting mild hearing loss (>20-25 dB), single-question screening had a pooled sensitivity of 66% (95% CI, 58%-73%) and pooled specificity of 76% (95% CI, 68%-83%) (10 studies, n = 12 637)[21,27,39,41,49,51,58,61,62,64]; for single-question screening for detecting moderate hearing loss (>35-40 dB averaged over 2-4 frequencies), pooled sensitivity was 80% (95% CI, 68%-88%) and pooled specificity was 74% (95% CI, 59%-85%) (6 studies, n = 8774).[21,28,39,49,51,55] Too few studies reported sufficient data to pool accuracy of the HHIE-S for detecting mild hearing loss (>25 dB at 2-4 frequencies); across 4 studies (n = 7194), sensitivity of HHIE-S (score >8) ranged from 34% to 58% and specificity from 76% to 95%.[34,49,50,58] For detecting moderate hearing loss (>40 dB at 2-4 frequencies), the pooled sensitivity of HHIE-S using a score of greater than 8 (5 studies, n = 2820) was 68% (95% CI, 52%-81%) and pooled specificity was 78% (95% CI, 67%-86%).[46,47,49,50,55] For detecting mild hearing loss (>25-30 dB), pooled sensitivity of the whispered voice test was 94% (95% CI, 31%-100%) and pooled specificity was 87% (82%-90%) (5 studies, n = 669).[33,41,48,57,60] Fewer studies reported on the accuracy of whispered voice to detect moderate hearing loss (>40 dB); sensitivity ranged from 30% to 60% and specificity from 80% to 98% (3 studies, n = 296).[22,33,41] Two studies (n = 215) assessed the accuracy of a screening audiometer to detect at least mild hearing loss (>25 to >30 dB); sensitivity ranged from 64% to 93% and specificity from 70% to 91%.[50,52] For detecting moderate hearing loss (>40 dB), 4 studies (n = 411) found relatively high sensitivity (94%-100%) and variable specificity (24%-80%) for the screening audiometer.[47,48,50,53]

Harms of Screening

Key Question 3A. What are the harms of screening for hearing loss in adults 50 years or older?

Key Question 3B. Do the harms of screening for hearing loss differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbid condition?

No eligible studies were identified.

Benefits of Interventions

Key Question 4A. What is the efficacy of interventions for screen-detected hearing loss in improving health outcomes in adults 50 years or older?

Six trials (reported in 8 articles) evaluated benefits of amplification compared with no amplification among populations with screen-detected or recently detected, untreated age-related hearing loss over 6 weeks to 4 months (**Table 2** reports study characteristics; eTables 24 and 25 in the Supplement report results).[31,32,35-37,42,43,45] In 5 trials reporting on the HHIE, 4 found statistically significant benefit in favor of hearing aids compared with no amplification (difference between groups in reduction from baseline score ranged from −34.0 to −6.8), and 1 crossover RCT found no significant differences between groups.[42] Three[35,43,45] of the 4 trials that found statistically significant benefit enrolled veterans (2 RCTs[35,43] and 1 nonrandomized controlled intervention study[45]); the difference in HHIE score changes from baseline in all 3 trials was greater than the 18.7-point difference considered to represent a minimal important difference (range,−34.0 to −19.3).[67] One RCT enrolling community volunteers found higher HHIE score changes from baseline among groups receiving 2 different hearing aid interventions (−18.2 points and −12.3 points) than placebo (−5.5 points); although comparisons were statistically significant for either intervention vs placebo (*P* < .001), differences between groups were less than the minimal important difference. Four studies reported on other non–hearing-related health outcomes (depression, general QOL, cognitive function)[31,42,43,45]; of these, 1 found significant benefit in favor of the intervention on the Short Portable Mental Status Questionnaire and the Geriatric Depression Scale (−0.28 points and −0.80 points, respectively).[43] No outcome measure was assessed by more than 1 study. Three studies reported outcomes but either did not provide numerical results[42] or did not report sufficient information to determine whether differences between groups were significant.[31,45] No study examined the effect of interventions on the incidence of dementia or neurocognitive impairment. The results are most applicable to older male populations with improved access to screening and no-cost hearing aids, such as veterans' groups.

Key Question 4B. Does the efficacy of interventions for screen-detected hearing loss differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbid condition?

No subpopulation analyses were reported by the included studies.

Harms of Interventions

Key Question 5A. What are the harms of interventions for screen-detected hearing loss in adults 50 years or older?

Key Question 5B. Do the harms of interventions for screen-detected hearing loss differ for subpopulations defined by age, sex, race/ethnicity, risk of past noise exposure, or comorbid condition?

No eligible studies were identified.

Discussion

This systematic review evaluated evidence related to screening for hearing loss in older adults. A summary of findings, including an assessment of the strength of evidence for each KQ, is presented in **Table 3**. The SAI-WHAT trial (n = 2305), included in the prior USPSTF review, found that screening was not associated

Table 1. Summary of Accuracy for Included Screening Tests (Key Question 2)

Test	Hearing loss severity (PTA dB range)	No. of studies (No. of participants)	% (95% CI)		LR (95% CI)	
			Sensitivity	Specificity	Positive	Negative
Single question	Mild (>20 to 25)	10 (12 637)[21,27,39,41,49,51,58,61,62,66a]	Pooled: 66 (58-73)	Pooled: 76 (68-83)	Pooled: 2.7 (2.2-3.4)	Pooled: 0.45 (0.38-0.53)
	Moderate (>35 to 40)	6 (8774)[21,28,39,49,51,55a]	Pooled: 80 (68-88)	Pooled: 74 (59-85)	Pooled: 3.1 (2.0-4.7)	Pooled: 0.27 (0.18-0.41)
HHIE-S score >8b	Mild (>25)	4 (7194)[34,49,50,58]	58 (53-61)[49]	85 (83-87)[49]	3.9 (3.8-3.9)[49]	0.49 (0.49-0.50)[49]
			58 (45-70)[50]	76 (69-84)[50]	2.4 (1.7-3.5)[50]	0.55 (NR)[50]
			44 (NR)[34]	85 (NR)[34]	2.9 (1.6-4.9)[34]	0.7 (0.6-0.8)[34]
			34 (31-37)[58]	95 (94-96)[58]	5.8 (6.6-7.0)[58]	0.69 (0.69-0.70)[58]
	Moderate (>40)	5 (2820)[46,47,49,50,55b]	Pooled: 68 (52-81)	Pooled: 78 (67-86)	Pooled: 3.21 (2.4-4.2)	Pooled: 0.41 (0.28-0.59)
HSAQ score ≥15	Mild (>25)	1 (112)[29]	100 (89-100)	75 (64-84)	4 (2.7-5.9)	0
RFMHT score ≥15	Mild (>25)	1 (74)[56]	80 (NR)	55 (NR)	1.8 (NR)	0.36 (NR)
Whispered voice test	Mild (>25 to 30)	5 (669)[33,41,48,57,60c]	Pooled: 94 (31-100)	Pooled: 87 (82-90)	Pooled: 7.1 (5.1-9.7)	Pooled: 0.06 (0.00-1.94)
	Moderate (>40)	3 (296)[22,41,57]	46 (36-56)[41]	78 (68-86)[41]	2.08 (NR)[41]	0.69 (NR)[41]
			30[d] (8-65)[22]	100[d] (92-100)[22]	NR[22]	0.69[22,d]
			100 (95-100)[57]	84 (70-81)[57]	6.0 (4.7-7.7)[57]	0.0 (NR)[57]
Watch tick	Mild (>25)	1 (107)[41]	44 (35-53)	100 (NR)	NR	0.56 (NR)
	Moderate (>40)	1 (107)[41]	60 (50-69)	99 (92-100)	60.0 (NR)	0.40 (NR)
Finger rub	Mild (>25)	1 (107)[41]	27 (20-36)	98 (85-100)	13.5 (NR)	0.74 (NR)
	Moderate (>40)	1 (107)[41]	35 (26-46)	97 (90-99)	11.67 (NR)	0.67 (NR)
Digits in noise	Mild (>20 to 25)	3 (4110)[24-26]	79 (77-81)[24]	76 (74-78)[24]	3.3 (3.3-3.3)[24]	0.28 (0.27-0.28)[24]
			80 (66-92)[26]	83 (69-92)[26]	4.7 (3.5-6.3)[26]	0.25 (0.20-0.30)[26]
			81 (79-84)[25]	65 (60-70)[25]	2.3 (2.3-2.4)[25]	0.29 (0.28-0.29)[25]
Words in noise	Mild (>25)	1 (1049)[25]	97 (96-98)[25]	46 (39-52)[25]	1.8 (1.8-1.8)[25]	0.06 (0.05-0.06)[24]
Handheld screening audiometry	Mild (>25 to 30)	2 (215)[50,52]	71 (63-80)[50]	91 (84-97)[50]	7.5 (3.7-15.4)[50]	0.32 (NR)[50]
			93 (NR)[52]	70 (NR)[52]	3.1 (NR)[52]	0.10 (NR)[52]
	Moderate (>40)	4 (411)[47,48,50,53e]	100 (91-100)[48]	42 (32-57)[48]	1.72 (NR)[48]	0[48]
			96 (90-100)[50]	80 (74-87)[50]	4.9 (3.5-6.9)[50]	0.05 (NR)[50]
			98 (NR)[53]	24 (NR)[53]	1.29 (NR)[53]	0.08 (NR)[53]
			94 (85-98)[47]	72 (64-79)[47]	3.4 (3.2-3.6)[47]	0.08 (0.04-0.15)[47]
Pure-tone portable audiometer screener	Moderate (>40)	1 (405)[54]	50-59 y: 94 (NR) 60-69 y: 90 (NR) 70-79 y: 90 (NR) 80-89 y: 90 (NR) 90-96 y: 88 (NR)	50-59 y: 93 (NR) 60-69 y: 94 (NR) 70-79 y: 92 (NR) 80-89 y: 90 (NR) 90-96 y: 93 (NR)	50-59 y: 13.4 (NR) 60-69 y: 15.6 (NR) 70-79 y: 10.6 (NR) 80-89 y: 9.2 (NR) 90-96 y: 11.8 (NR)	50-59 y: 0.06 (NR) 60-69 y: 0.11 (NR) 70-79 y: 0.11 (NR) 80-89 y: 0.11 (NR) 90-96 y: 0.13 (NR)
uHear app	Moderate (>40)	2 (78)[22,30d]	68 (45-86)[30]	87 (76-94)[30]	NR	NR
			100 (66-100)[22]	89 (77-96)[22]		

(continued)

Table 1. Summary of Accuracy for Included Screening Tests (Key Question 2) (continued)

Test	Hearing loss severity (PTA dB range)	No. of studies (No. of participants)	% (95% CI) Sensitivity	% (95% CI) Specificity	LR (95% CI) Positive	LR (95% CI) Negative
EarTrumpet app	Moderate (>40 dB)	1 (33)[23]	88 (64-97)[23]	96 (86-99)[23]	21.4 (7.9-58.3)[23]	0.13 (0.05-0.35)[23]
	Mild (>20 dB)	1 (35)[38]	Quiet examination room: 96.3 (NR) Clinic waiting area: 100 (NR)	Quiet examination room: 83.1 (NR) Clinic waiting area: 72 (NR)	NR	NR
ShoeBOX app	Moderate (>40 dB)	1 (33)[23]	100 (81-100)[23]	96 (86-99)[23]	24.5 (9.2-65.3)[23]	0[23]
Audiogram mobile app	Mild (>20 dB)	1 (37)[38]	Quiet examination room: 85.3 (NR) Clinic waiting area: 87.6 (NR)	Quiet examination room: 95.1 (NR) Clinic waiting area: 92.3 (NR)	NR	NR
Hearing test with Audiogram app	Mild (>20 dB)	1 (35)[38]	Quiet examination room: 87.8 (NR) Clinic waiting area: 89 (NR)	Quiet examination room: 69.4 (NR) Clinic waiting area: 68.2 (NR)	NR	NR

Abbreviations: HHIE-S, Hearing Handicap Inventory for the Elderly–Screening version; HSAQ, Hearing Self-Assessment Questionnaire; LR, likelihood ratio; NR, not reported; PTA, pure-tone average; RFMHT, Revised Five-Minute Hearing Test; WIN, words in noise; WVT, whispered voice test.

[a] One additional study of 1731 community-dwelling adults in Japan that did not report sufficient data to be included in pooled analyses of single-question screeners found a sensitivity of 54% and specificity of 78% for detecting mild hearing loss and a sensitivity of 88% and a specificity of 67% for detecting moderate hearing loss.[34]

[b] One additional study of 1731 community-dwelling adults in Japan that did not report sufficient data to be included in pooled analyses of HHIE-S using a cutoff score of greater than 8 found similar accuracy for detecting moderate hearing loss (81% sensitivity and 78% specificity).[34]

[c] Of these, 1 study (n = 62) also assessed the accuracy of conversational voice at 2 feet and reported low sensitivity (47%) and high specificity (100%) for detecting mild hearing loss.[57]

[d] Estimates here are based on a positive screening test definition of 2 or more consecutive hearing grades starting from the moderate-severe threshold zone ranging from 0.5 to 2.0 kHz. Using a scoring method that defined a positive screening test result based on PTA of 40 dB or greater at 0.5, 1.0, or 2.0 kHz, sensitivity was high in both cohorts (100%), but specificity was relatively low (38% and 36%).[22,30]

[e] One additional study assessed the accuracy of both the handheld screening audiometer and a portable audiometer to detect moderate hearing loss (≥45 dB) in subpopulations defined by age decades (50- to 90-year-olds). Across all age groups, the handheld screening audiometry sensitivities ranged from 85% to 90% and specificities from 89% to 94%. Similarly, sensitivities for the portable audiometer ranged from 88% to 94% and specificities from 90% to 94%.[54]

Table 2. Characteristics of Randomized Clinical Trials of Benefits (Key Question 4) of Treatment for Hearing Loss

Source	Study design (No. of participants)	Setting (country)	Source population	Eligibility criteria	Age, mean (SD), y	% Male	% White	Baseline hearing loss
Humes et al,[32] 2017	Double-blind RCT (154)	Community (US)	Participants recruited via ads posted in local newspapers and around the community for a trial at Indiana University, Bloomington	Aged 55-79 y; English-speaking; MMSE score >25; no prior hearing aid experience; PTA thresholds consistent with age-related, bilateral SNHL; no hearing-related pathologies specific to ear anatomy, medication use, or medical conditions; willingness to be randomized	69 (6)	56	98	Bilateral PTA (500, 1000, and 2000 Hz); mean, 28.1 (SD, 8.0) dB Bilateral high-frequency PTA (1000, 2000, and 4000 Hz); mean, 38.8 (SD, 7.9) dB
Jerger et al,[42] 1996	Crossover RCT (80)	Community (US)	Paid participants recruited via ads in community centers in Houston, Texas	Aged >60 y; bilateral high-frequency SNHL>15 dB in both ears; normal middle ear status; average score ≤3 on self-report physical health scale; normal MMSE score (≥24); no history of neurologic or psychiatric disorder	74 (range, 60-96)	63	NR	Bilateral PTA (500, 1000, and 2000 Hz); mean, 37.4 dB
McArdle et al,[35] 2005 Chisolm et al,[36] 2005	Unblinded RCT (380)	VA audiology clinic (US)	Community-dwelling participants from the general audiology clinics at 4 VA medical centers who were eligible to receive no-cost hearing aids	Adult-onset SNHL; no asymmetry of PTA thresholds or speech-recognition scores in quiet; no prior HA use; "passing" MMSE score; at least a mild, high-frequency BEHL ≥30 dB at 2000, 3000, and 4000 Hz; no known conductive or retrocochlear pathologies, neurologic or psychiatric disorders, or significant comorbid diseases; access to a telephone	69.4 (9.0)	98	NR	NR
Mulrow et al,[43] 1990	Unblinded RCT (194)	VA primary care clinic (US)	Participants from 1 VA general medicine clinic invited for hearing screening and follow-up diagnostic testing to determine eligibility; or from other VA clinics at same institution with hearing impairment referred by primary care providers	Aged >64 y; formal audiologic testing confirmed hearing loss; residence <100 mi from clinic; no current hearing aid use; no severe disabling comorbidities[a]	72 (NR)	Hearing aid group: 100 Control: 99	Hearing aid group: 98 Control: 96	Better ear PTA (1000, 2000, and 4000 Hz); mean, 52 dB
Nieman et al,[31] 2017	Unblinded RCT (15)	Community (US)	Community-dwelling adults recruited from 3 buildings that house low- to middle-income, predominantly African American older adults subsidized by a nonprofit in Baltimore, Maryland, recruited via flyers and invitations from service coordinators in each building	Aged ≥60 y; English speaking; clinically significant mild or worse hearing loss; no current hearing aid use; had communication partner who would participate in study (≥18 y who spoke with participant daily)	Median (IQR): 70 (67-76)	47	40	Better ear PTA (1000, 2000, and 4000 Hz); median, 40 (IQR, 32.5-53.3) dB
Yueh et al,[45] 2001	Unblinded RCT (30)	VA audiology clinic (US)	Veterans seeking diagnostic visits or hearing aid evaluations at the audiology clinic of VA Puget Sound Health Care System	Aged ≥50 y; diagnosed with symmetric, bilateral, mild to moderately severe sensorineural hearing loss; no asymmetric or conductive hearing loss; or atypical causes of SNHL; no prior hearing aid use; good cognitive function; and normal manual dexterity	69 (NR)	100	NR	Mean PTA, right ear: 32.9 dB Mean PTA, left ear: 32.4 dB

Abbreviations: BEHL, best ear hearing level; HA, hearing aid; IQR, interquartile range; MMSE, Mini-Mental State Examination; NR, not reported; PTA, pure-tone average; RCT, randomized clinical trial; SNHL, sensorineural hearing loss; VA, Veterans Administration.

[a] Terminal cancer, hepatic encephalopathy, and end-stage pulmonary disease requiring home oxygen therapy; residence more than 100 miles from clinic.

Table 3. Summary of Evidence: Screening and Treatment for Hearing Loss in Older Adults

No. of studies (No. of participants)	Summary of findings	Consistency and precision	Limitations (including reporting bias)	Overall strength of evidence	Applicability
KQ1: Benefits of screening					
1 RCT (2305)	One RCT found that screening with HHIE-S, handheld screening audiometer, or both was not associated with any significant differences in hearing-related QOL compared with no screening	Consistency unknown; imprecise	High overall attrition (23% for hearing-related function); not designed to assess differences in hearing-related QOL	Insufficient	Participants recruited from a VA setting with high prevalence of hearing loss (74% reported perceived hearing loss at baseline) and all patients were eligible to receive free hearing aids; results may not be applicable to lower-prevalence settings in which the cost of or access to hearing aids is a barrier
KQ2: Accuracy of screening					
10 (12 637) Single question for mild (>20 to 25 dB) hearing loss	Pooled sensitivity: 66% (58%-73%) Pooled specificity: 76% (68%-83%)	Mostly consistent[a]; imprecise (more imprecise for sensitivity than for specificity)	Only 1 study specified how equivocal screening test responses were handled; hearing loss definitions varied in frequencies measured and ears affected	Moderate for adequate accuracy	Most studies conducted in specialty or other high-prevalence settings
4 (7194) HHIE-S score >8 for mild (>20 to 25 dB) hearing loss	Sensitivity range, 34% to 58% across studies Specificity range, 76% to 95% across studies	Mostly consistent (more consistent for specificity than for sensitivity); imprecise	Hearing loss definitions varied in frequencies measured and ears affected	Low for adequate accuracy	Most studies conducted in specialty or other high-prevalence settings
5 (669) WVT for mild (>20 to 25 dB) hearing loss	Pooled sensitivity: 94% (31%-100%) Pooled specificity: 87% (82%-90%)	Inconsistent; imprecise (more imprecise for sensitivity than for specificity)[b]	Hearing loss definitions varied in thresholds (>25, >29, and >30 dB) and number of frequencies measured; 1 study found inconsistent results based on experience level of whisperer[33]	Low for adequate accuracy	Most studies conducted in specialty or other high-prevalence settings where screening was delivered by hearing specialists
2 (215) Handheld screening audiometry for mild (>20 to 25 dB) hearing loss	Sensitivity range, 71% to 93% across studies Specificity range, 70% to 91% across studies	Inconsistent; imprecise	Studies used different criteria to determine a positive screen, based on the handheld screening audiometer (number of frequencies; specific frequencies included)	Insufficient	Both studies conducted in specialty settings
2 (3417) DIN for mild (>20 to 25 dB) hearing loss	Sensitivity range, 79% to 80% across studies Specificity range, 76% to 83% across studies	Consistent; imprecise (more imprecise for specificity than for sensitivity)	Methods of administering screening test varied across studies	Low for adequate accuracy	Screening tests were administered by audiologists
6 (8774) Single question for moderate (>35 to 40 dB) hearing loss	Pooled sensitivity: 80% (68%-88%) Pooled specificity: 74% (59%-85%)	Inconsistent[c]; precise (more precise for sensitivity than for specificity)	Only 1 study specified how equivocal screening test responses were handled; hearing loss definitions varied in frequencies measured and ears affected	Moderate for adequate accuracy	Most studies conducted in specialty or other high-prevalence settings
5 (2820) HHIE-S score >8 for moderate (>35 to 40 dB) hearing loss	Pooled sensitivity: 68% (52%-81%) Pooled specificity: 66% (55%-79%)	Mostly consistent; imprecise[d]	HL definitions varied in frequencies measured and ears affected	Moderate for adequate accuracy	Most studies were conducted in specialty or other high-prevalence settings
3 (296) WVT for moderate (>35 to 40 dB) hearing loss	Sensitivity range, 30% to 100% across studies Specificity range, 79% to 100% across studies	Inconsistent; imprecise (more imprecise for sensitivity)	Hearing loss definitions varied in terms of frequencies measured and ears affected; 1 study found inconsistent results based on experience level of whisperer[33]	Low for inadequate accuracy	Studies were conducted in specialty or other high-prevalence settings in which screening was delivered by hearing specialists

(continued)

Table 3. Summary of Evidence: Screening and Treatment for Hearing Loss in Older Adults (continued)

No. of studies (No. of participants)	Summary of findings	Consistency and precision	Limitations (including reporting bias)	Overall strength of evidence	Applicability
4 (411) Handheld screening audiometry for moderate (>35 to 40 dB) hearing loss	Sensitivity range, 94% to 100% across studies Specificity range, 24% to 80% across studies	Mostly consistent (more consistent for sensitivity than for specificity); precise (more precise for sensitivity than for specificity)	Studies used different criteria to define a positive screen on screening audiometry; hearing loss definitions varied in frequencies measured	Moderate for adequate accuracy	Studies were conducted in specialty settings or other high-prevalence settings
2 (78) uHear app for moderate (>35 to 40 dB) hearing loss	Sensitivity range, 68% to 100% across studies Specificity range, 87% to 89% across studies	Inconsistent (more for sensitivity than for specificity); imprecise (more for sensitivity than for specificity)	Sensitivity varied within studies based on positive screening test definition and between studies using the same screening test definition	Insufficient	Both studies enrolled older adults with cancer undergoing a comprehensive geriatric assessment
KQ3: Harms of screening					
0	No eligible studies	NA	NA	Insufficient	NA
KQ4: Benefits of interventions for screen-detected hearing loss					
6 RCTs (3188) (8 publications)	In 5 trials (n = 3173) reporting on the HHIE, 4 found significant benefit in favor of hearing aids vs no amplification over 6 wk to 4 mo, and 1 crossover trial found no significant difference between groups over 6 wk Few studies reported on other hearing-related outcomes	Consistent, imprecise	Most studies were unblinded; follow-up duration was relatively short (6 wk to 4 mo); only 1 study enrolled participants identified by screening in primary care	Low	Three of 4 studies showing benefit enrolled populations from VA settings with baseline HHIE scores indicating moderate hearing loss handicap (46-51) and who were eligible to receive free hearing aids
KQ5: Harms of interventions for screen-detected hearing loss					
0	No eligible studies	NA	NA	Insufficient	NA

Abbreviations: HHIE-S, Hearing Handicap Inventory for the Elderly–Screening; KQ, key question; NA, not applicable; QOL, quality of life; RCT, randomized clinical trial; VA, Veterans Affairs; WVT, whispered voice test.

[a] Based on eFigure 1 in the Supplement, the 95% prediction region indicates that the results are reasonably consistent; based on the 95% confidence interval, estimates are imprecise.

[b] Based on eFigure 4 in the Supplement, the 95% prediction region indicates the results are moderately inconsistent; based on the 95% confidence region, estimates are imprecise (more imprecise for sensitivity than specificity).

[c] Based on eFigure 2 in the Supplement, the 95% prediction region indicates the results are moderately inconsistent; based on the 95% confidence region, estimates are imprecise.

[d] Based on eFigure 3 in the Supplement, the 95% prediction region is relatively large, covering approximately one-third of the receiver operating characteristic space; the 95% confidence region is relatively precise (more precise for sensitivity than specificity).

with any statistically significant difference in hearing-related QOL compared with no screening at 1 year but was associated with greater hearing aid use among those screened with a handheld screening audiometer or combined screening with a screening audiometer and HHIE-S questionnaire compared with no screening (the primary outcome of SAI-WHAT).[44,65] Most enrolled participants (74%) reported perceived hearing loss at baseline (based on the single question "Do you think you have a hearing loss?"), and effects of screening on hearing aid use appeared to be limited to patients with perceived hearing loss at baseline based on stratified analyses. The SAI-WHAT trial was not powered to assess improvements in hearing-related function, and rates of hearing aid use at 1 year were relatively low (less than 10% in all groups) despite being provided at no cost. However, 36% to 40% of participants (screened or unscreened) experienced a clinically significant improvement in hearing-related function, suggesting that factors other than hearing aid use may affect functional outcomes. Although no new studies directly evaluating screening were identified, findings from a recent uncontrolled intervention study (n = 14 411) of an electronic alert to encourage primary care clinicians to screen for hearing loss using a single question ("Do you have difficulty with your hearing?") are consistent with those from the SAI-WHAT trial in showing an increase in referrals associated with screening (from 2.2% at baseline to 10.7% during the study period).[68] Among those referred (n = 1660), 43% were evaluated by an audiologist and 59% (n = 421) were considered candidates for hearing aids. Rates of hearing aid use or changes in health outcomes were not reported; however, in a subset of participants who agreed to a 3-month follow-up (n = 557), only 50% of those who had hearing aids recommended planned to get them, primarily because of cost.[68] Multiple factors may explain low uptake of hearing aids among those with perceived hearing impairment, confirmed hearing impairment, or both, including a perception that symptoms are not severe enough, concerns about cost or stigma, and (for those who receive hearing aids) concerns about comfort and maintenance (eg, difficulty replacing batteries, cost of repairs).[69-72] The eContextual Questions in the Supplement provide a detailed overview of issues related to adherence, potential barriers to obtaining hearing aids, adherence, and reasons for low uptake.

Similar to the 2012 review for the USPSTF,[12] no direct evidence on harms of screening was found. Potential harms include false-positive results that lead to unnecessary testing and/or treatment, labeling, and anxiety. For example, based on the pooled analyses of HHIE-S for detecting moderate hearing loss (5 studies; n = 2820), the expected rate of false-positive test results would be 22% (Table 3). Other harms of screening are likely to be minimal because screening is noninvasive, and the reference standard (audiometric testing) is also noninvasive.

Most included studies reported on the accuracy of various screening tests to identify hearing loss (34 studies). Although available screening tools for clinical practice may reasonably identify asymptomatic older adults with hearing loss, this systematic review highlights the variability in estimates of screening test accuracy. The use of different thresholds and criteria to define hearing loss is a major limitation in interpreting studies and making stronger conclusions about the accuracy of available tests. Several studies found inconsistent screening test accuracy results when comparing the same screening test (and cutpoint) with different definitions for mild or moderate hearing loss (ie, measured at different frequencies or defined by hearing thresholds in the better vs worse ear). Screening tests evaluated in the included studies differ in factors such as cost, complexity/time, and convenience. Relatively simple tests, such as a single question regarding perceived hearing loss, appeared to be nearly as accurate as a more detailed hearing loss questionnaire or a handheld audiometric device for detecting hearing loss. Some studies were limited by unclear applicability to primary care (14 of 34 studies enrolled participants from audiology clinics or other hearing-related specialties). Overall, accuracy estimates were derived from populations with a prevalence of hearing loss (based on pure-tone audiometry) of approximately 14% to 63% for mild (>25 dB) and 11% to 69% for moderate (>40 dB) hearing loss. The clinical relevance of detection of mild (25-40 dB) hearing loss as it pertains to effectiveness of screening is uncertain because the only trial showing benefits of hearing aids among participants screen-detected limited eligibility to those with moderate (>40 dB) hearing loss.[44]

Despite a relatively large body of observational studies indicating an association between hearing loss and higher rates of disability,[5] depressive symptoms,[7] cognitive decline,[8] and other adverse health and social outcomes, evidence on the efficacy of treatments for screen-detected hearing loss in primary care settings remains limited. The 6 included studies in this review are heterogeneous in terms of enrolled populations and amplification interventions; few reported on outcomes other than hearing-related function, and follow-up duration was relatively short (ranging from 6 weeks to 4 months).[31,32,35-37,42,43,45] No new studies enrolling screen-detected populations from primary care settings were identified. Trials showing clinically meaningful benefit in hearing-related function associated with hearing aids enrolled veterans with baseline HHIE scores indicating at least mild to moderate hearing-related handicap.[35,43,45] Only 1 of these trials enrolled participants detected by screening in a primary care center and almost exclusively enrolled White men eligible for free VA hearing aids, and its applicability to other settings may be limited.[37,43]

The conclusions of this review that hearing aid use is associated with improved hearing-related function are similar to those from a 2017 Cochrane review (5 RCTs, n = 825), despite differences in eligible populations and study designs. Authors concluded that hearing aids significantly improve hearing-related function measured by the HHIE compared with the unaided/placebo condition (mean difference, −26.47 [95% CI, −42.16 to −10.77]; 3 studies, n = 722).[73] Research is needed to determine if hearing aids or other amplification devices among populations with screen-detected hearing loss translate into longer-term benefits, such as lower rates of functional impairment or dementia. Populations enrolled in studies recruiting from the community may be more likely to include those who have known or perceived hearing loss but have not yet sought care because of various barriers. Whether earlier detection due to screening and provision of amplification improves outcomes is not clear based on existing evidence.

No direct evidence on harms associated with amplification was detected. However, harms are likely to be minimal because hearing aid use is not known to be associated with serious adverse events.

Limitations

This review has several limitations. First, studies enrolling persons with symptomatic hearing loss and head-to-head comparisons of different interventions were excluded because the scope was designed to provide evidence on benefits of treatments compared with no treatment rather than assess the comparative effectiveness of amplification devices or other interventions. Second, for studies related to benefits of screening and interventions for screen-detected populations, the review was limited to study designs that included a control group and those that reported on health outcomes. Intermediate outcomes, including increased rates of audiology referrals associated with screening, may not indicate that people identified by routine screening have better long-term health outcomes than those who are identified and referred for treatment in the context of routine primary care. Third, the review excluded studies focused on adults younger than 50 years and studies focused on other causes of hearing loss (eg, prevention of noise-induced hearing loss) because it was intended to inform screening for age-related hearing loss in primary care settings.

Conclusions

Several screening tests can adequately detect hearing loss in older adults; no studies reported on the harms of screening or treatment. Evidence showing benefit from hearing aids on hearing-related function among adults with screen-detected or newly detected hearing loss is limited to studies enrolling veterans.

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Concept and design: All authors.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: All authors.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Feltner, Wallace, Kistler.
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REFERENCES

1. Gates GA, Mills JH. Presbycusis. *Lancet*. 2005; 366(9491):1111-1120. doi:10.1016/S0140-6736(05)67423-5

2. Curti SA, Taylor EN, Su D, Spankovich C. Prevalence of and characteristics associated with self-reported good hearing in a population with elevated audiometric thresholds. *JAMA Otolaryngol Head Neck Surg*. 2019;145(7):626-633. doi:10.1001/jamaoto.2019.1020

3. Choi JE, Moon IJ, Baek SY, Kim SW, Cho YS. Discrepancies between self-reported hearing difficulty and hearing loss diagnosed by audiometry: prevalence and associated factors in a national survey. *BMJ Open*. 2019;9(4):e022440. doi:10.1136/bmjopen-2018-022440

4. Hoffman HJ, Dobie RA, Losonczy KG, Themann CL, Flamme GA. Declining prevalence of hearing loss in US adults aged 20 to 69 years. *JAMA Otolaryngol Head Neck Surg*. 2017;143(3):274-285. doi:10.1001/jamaoto.2016.3527

5. Chen DS, Betz J, Yaffe K, et al; Health ABC Study. Association of hearing impairment with declines in physical functioning and the risk of disability in older adults. *J Gerontol A Biol Sci Med Sci*. 2015;70(5):654-661. doi:10.1093/gerona/glu207

6. Mick P, Kawachi I, Lin FR. The association between hearing loss and social isolation in older adults. *Otolaryngol Head Neck Surg*. 2014;150(3): 378-384. doi:10.1177/0194599813518021

7. Lisan Q, van Sloten TT, Lemogne C, et al. Association of hearing impairment with incident depressive symptoms: a community-based prospective study. *Am J Med*. 2019;132(12):1441-1449. doi:10.1016/j.amjmed.2019.05.039

8. Loughrey DG, Kelly ME, Kelley GA, Brennan S, Lawlor BA. Association of age-related hearing loss with cognitive function, cognitive impairment, and dementia: a systematic review and meta-analysis. *JAMA Otolaryngol Head Neck Surg*. 2018;144(2):115-126. doi:10.1001/jamaoto.2017.2513

9. Moyer VA; US Preventive Services Task Force. Screening for hearing loss in older adults: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2012;157(9):655-661. doi:10.7326/0003-4819-157-9-201211060-00526

10. Feltner CW, Kistler C, Coker-Schwimmer M, Jonas DE, Middleton JC. *Screening for Hearing Loss in Older Adults: An Evidence Review for the U.S. Preventive Services Task Force. Evidence Synthesis No. 200*. Agency for Healthcare Research and Quality; 2021. AHRQ publication 20-05269-EF-1.

11. Procedure Manual. US Preventive Services Task Force. Published 2015. Accessed December 17, 2019. https://www.uspreventiveservicestaskforce.org/Page/Name/procedure-manual

12. Chou R, Dana T, Bougatsos C, Fleming C, Beil T. Screening adults aged 50 years or older for hearing loss: a review of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med*. 2011;154(5):347-355. doi:10.7326/0003-4819-154-5-201103010-00009

13. Everett A, Wong A, Piper R, Cone B, Marrone N. Sensitivity and specificity of pure-tone and subjective hearing screenings using Spanish-language questions. *Am J Audiol*. 2020;29(1):35-49. doi:10.1044/2019_AJA-19-00053

14. Kam ACS, Fu CHT. Screening for hearing loss in the Hong Kong Cantonese-speaking elderly using tablet-based pure-tone and word-in-noise test. *Int J Audiol*. 2020;59(4):301-309. doi:10.1080/14992027.2019.1696992

15. Human Development Index. United Nations Development Programme. Published 2016.

Accessed August 20, 2018. http://hdr.undp.org/en/composite/HDI

16. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898. doi:10.1136/bmj.l4898

17. Higgins JPT, Sterne JAC, Savović J, et al. A revised tool for assessing risk of bias in randomized trials. In: Chandler J, McKenzie J, Boutron I, Welch V, eds. *Cochrane Methods.* Vol 10. Cochrane Collaboration; 2016.

18. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919. doi:10.1136/bmj.i4919

19. Whiting PF, Rutjes AW, Westwood ME, et al; QUADAS-2 Group. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. *Ann Intern Med*. 2011;155(8):529-536. doi:10.7326/0003-4819-155-8-201110180-00009

20. *Stata Statistical Software: Release 14.0.* StataCorp; 2015.

21. Swanepoel W, Eikelboom RH, Hunter ML, Friedland PL, Atlas MD. Self-reported hearing loss in baby boomers from the Busselton Healthy Ageing Study: audiometric correspondence and predictive value. *J Am Acad Audiol*. 2013;24(6):514-521. doi:10.3766/jaaa.24.6.7

22. Lycke M, Boterberg T, Martens E, et al. Implementation of uHear™—an iOS-based application to screen for hearing loss—in older patients with cancer undergoing a comprehensive geriatric assessment. *J Geriatr Oncol*. 2016;7(2):126-133. doi:10.1016/j.jgo.2016.01.008

23. Saliba J, Al-Reefi M, Carriere JS, Verma N, Provencal C, Rappaport JM. Accuracy of mobile-based audiometry in the evaluation of hearing loss in quiet and noisy environments. *Otolaryngol Head Neck Surg*. 2017;156(4):706-711. doi:10.1177/0194599816683663

24. Koole A, Nagtegaal AP, Homans NC, Hofman A, Baatenburg de Jong RJ, Goedegebure A. Using the digits-in-noise test to estimate age-related hearing loss. *Ear Hear*. 2016;37(5):508-513. doi:10.1097/AUD.0000000000000282

25. Williams-Sanchez V, McArdle RA, Wilson RH, Kidd GR, Watson CS, Bourne AL. Validation of a screening test of auditory function using the telephone. *J Am Acad Audiol*. 2014;25(10):937-951. doi:10.3766/jaaa.25.10.3

26. Watson CS, Kidd GR, Miller JD, Smits C, Humes LE. Telephone screening tests for functionally impaired hearing: current use in seven countries and development of a US version. *J Am Acad Audiol*. 2012;23(10):757-767. doi:10.3766/jaaa.23.10.2

27. Hannula S, Bloigu R, Majamaa K, Sorri M, Mäki-Torkko E. Self-reported hearing problems among older adults: prevalence and comparison to measured hearing impairment. *J Am Acad Audiol*. 2011;22(8):550-559. doi:10.3766/jaaa.22.8.7

28. Lee AT, Tong MC, Yuen KC, Tang PS, Vanhasselt CA. Hearing impairment and depressive symptoms in an older Chinese population. *J Otolaryngol Head Neck Surg*. 2010;39(5):498-503.

29. Bonetti L, Šimunjak B, Franić J. Validation of self-reported hearing loss among adult Croatians: the performance of the Hearing Self-Assessment Questionnaire against audiometric evaluation. *Int J Audiol*. 2018;57(1):1-9. doi:10.1080/14992027.2017.1355073

30. Lycke M, Debruyne PR, Lefebvre T, et al. The use of uHear™ to screen for hearing loss in older patients with cancer as part of a comprehensive geriatric assessment. *Acta Clin Belg*. 2018;73(2):132-138. doi:10.1080/17843286.2017.1392070

31. Nieman CL, Marrone N, Mamo SK, et al. The Baltimore HEARS Pilot study: an affordable, accessible, community-delivered hearing care intervention. *Gerontologist*. 2017;57(6):1173-1186. doi:10.1093/geront/gnw153

32. Humes LE, Rogers SE, Quigley TM, Main AK, Kinney DL, Herring C. The effects of service-delivery model and purchase price on hearing-aid outcomes in older adults: a randomized double-blind placebo-controlled clinical trial. *Am J Audiol*. 2017;26(1):53-79. doi:10.1044/2017_AJA-16-0111

33. McShefferty D, Whitmer WM, Swan IRC, Akeroyd MA. The effect of experience on the sensitivity and specificity of the whispered voice test: a diagnostic accuracy study. *BMJ Open*. 2013;3(4):e002394. doi:10.1136/bmjopen-2012-002394

34. Tomioka K, Ikeda H, Hanaie K, et al. The Hearing Handicap Inventory for Elderly-Screening (HHIE-S) versus a single question: reliability, validity, and relations with quality of life measures in the elderly community, Japan. *Qual Life Res*. 2013;22(5):1151-1159. doi:10.1007/s11136-012-0235-2

35. McArdle R, Chisolm TH, Abrams HB, Wilson RH, Doyle PJ. The WHO-DAS II: measuring outcomes of hearing aid intervention for adults. *Trends Amplif*. 2005;9(3):127-143. doi:10.1177/108471380500900304

36. Chisolm TH, Abrams HB, McArdle R, Wilson RH, Doyle PJ. The WHO-DAS II: psychometric properties in the measurement of functional health status in adults with acquired hearing loss. *Trends Amplif*. 2005;9(3):111-126. doi:10.1177/108471380500900303

37. Mulrow CD, Tuley MR, Aguilar C. Sustained benefits of hearing aids. *J Speech Hear Res*. 1992;35(6):1402-1405. doi:10.1044/jshr.3506.1402

38. Kelly EA, Stadler ME, Nelson S, Runge CL, Friedland DR. Tablet-based screening for hearing loss: feasibility of testing in nonspecialty locations. *Otol Neurotol*. 2018;39(4):410-416. doi:10.1097/MAO.0000000000001752

39. Oosterloo BC, Homans NC, Baatenburg de Jong RJ, Ikram MA, Nagtegaal AP, Goedegebure A. Assessing hearing loss in older adults with a single question and person characteristics: comparison with pure tone audiometry in the Rotterdam Study. *PLoS One*. 2020;15(1):e0228349-e. doi:10.1371/journal.pone.0228349

40. López-Torres Hidalgo J, Boix Gras C, Téllez Lapeira J, López Verdejo MA, del Campo del Campo JM, Escobar Rabadán F. Functional status of elderly people with hearing loss. *Arch Gerontol Geriatr*. 2009;49(1):88-92. doi:10.1016/j.archger.2008.05.006

41. Boatman DF, Miglioretti DL, Eberwein C, Alidoost M, Reich SG. How accurate are bedside hearing tests? *Neurology*. 2007;68(16):1311-1314. doi:10.1212/01.wnl.0000259524.08148.16

42. Jerger J, Chmiel R, Florin E, Pirozzolo F, Wilson N. Comparison of conventional amplification and an assistive listening device in elderly persons. *Ear Hear*. 1996;17(6):490-504. doi:10.1097/00003446-199612000-00005

43. Mulrow CD, Aguilar C, Endicott JE, et al. Quality-of-life changes and hearing impairment: a randomized trial. *Ann Intern Med*. 1990;113(3):188-194. doi:10.7326/0003-4819-113-3-188

44. Yueh B, Collins MP, Souza PE, et al. Long-term effectiveness of screening for hearing loss: the Screening for Auditory Impairment—Which Hearing Assessment Test (SAI-WHAT) randomized trial. *J Am Geriatr Soc*. 2010;58(3):427-434. doi:10.1111/j.1532-5415.2010.02738.x

45. Yueh B, Souza PE, McDowell JA, et al. Randomized trial of amplification strategies. *Arch Otolaryngol Head Neck Surg*. 2001;127(10):1197-1204. doi:10.1001/archotol.127.10.1197

46. Ventry IM, Weinstein BE. Identification of elderly people with hearing problems. *ASHA*. 1983;25(7):37-42.

47. Lichtenstein MJ, Bess FH, Logan SA. Validation of screening tools for identifying hearing-impaired elderly in primary care. *JAMA*. 1988;259(19):2875-2878. doi:10.1001/jama.1988.03720190043029

48. Eekhof JA, de Bock GH, de Laat JA, Dap R, Schaapveld K, Springer MP. The whispered voice: the best test for screening for hearing impairment in general practice? *Br J Gen Pract*. 1996;46(409):473-474.

49. Sindhusake D, Mitchell P, Smith W, et al. Validation of self-reported hearing loss: the Blue Mountains Hearing Study. *Int J Epidemiol*. 2001;30(6):1371-1378. doi:10.1093/ije/30.6.1371

50. McBride WS, Mulrow CD, Aguilar C, Tuley MR. Methods for screening for hearing loss in older adults. *Am J Med Sci*. 1994;307(1):40-42. doi:10.1097/00000441-199401000-00007

51. Clark K, Sowers M, Wallace RB, Anderson C. The accuracy of self-reported hearing loss in women aged 60-85 years. *Am J Epidemiol*. 1991;134(7):704-708. doi:10.1093/oxfordjournals.aje.a116147

52. Bienvenue GR, Michael PL, Chaffinch JC, Zeigler J. The AudioScope: a clinical tool for otoscopic and audiometric examination. *Ear Hear*. 1985;6(5):251-254. doi:10.1097/00003446-198509000-00005

53. Ciurlia-Guy E, Cashman M, Lewsen B. Identifying hearing loss and hearing handicap among chronic care elderly people. *Gerontologist*. 1993;33(5):644-649. doi:10.1093/geront/33.5.644

54. Frank T, Petersen DR. Accuracy of a 40 dB HL Audioscope and audiometer screening for adults. *Ear Hear*. 1987;8(3):180-183. doi:10.1097/00003446-198706000-00009

55. Gates GA, Murphy M, Rees TS, Fraher A. Screening for handicapping hearing loss in the elderly. *J Fam Pract*. 2003;52(1):56-62.

56. Koike KJ, Hurst MK, Wetmore SJ. Correlation between the American Academy of Otolaryngology–Head and Neck Surgery five-minute hearing test and standard audiologic data. *Otolaryngol Head Neck Surg*. 1994;111(5):625-632. doi:10.1177/019459989411100514

57. Macphee GJ, Crowther JA, McAlpine CH. A simple screening test for hearing impairment in elderly patients. *Age Ageing*. 1988;17(5):347-351. doi:10.1093/ageing/17.5.347

58. Nondahl DM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein R, Klein BE. Accuracy of self-reported hearing loss. *Audiology*. 1998;37(5):295-301. doi:10.3109/00206099809072983

59. Sever JC Jr, Harry DA, Rittenhouse TS. Using a self-assessment questionnaire to identify probable hearing loss among older adults. *Percept Mot Skills*. 1989;69(2):511-514. doi:10.2466/pms.1989.69.2.511

60. Swan IR, Browning GG. The whispered voice as a screening test for hearing impairment. *J R Coll Gen Pract*. 1985;35(273):197.

61. Torre P, Moyer CJ, Haro NR. The accuracy of self-reported hearing loss in older Latino-American adults. *Int J Audiol*. 2006;45(10):559-562. doi:10.1080/14992020600860935

62. Voeks SK, Gallagher CM, Langer EH, Drinka PJ. Self-reported hearing difficulty and audiometric thresholds in nursing home residents. *J Fam Pract*. 1993;36(1):54-58.

63. Wiley TL, Cruickshanks KJ, Nondahl DM, Tweed TS. Self-reported hearing handicap and audiometric measures in older adults. *J Am Acad Audiol*. 2000;11(2):67-75.

64. Rawool VW, Keihl JM. Perception of hearing status, communication, and hearing aids among socially active older individuals. *J Otolaryngol Head Neck Surg*. 2008;37(1):27-42.

65. Yueh B, Collins MP, Souza PE, et al. Screening for Auditory Impairment–Which Hearing Assessment Test (SAI-WHAT): RCT design and baseline characteristics. *Contemp Clin Trials*. 2007;28(3):303-315. doi:10.1016/j.cct.2006.08.008

66. Kim TY, Park DW, Lee YJ, et al. Comparison of inner ear contrast enhancement among patients with unilateral inner ear symptoms in MR images obtained 10 minutes and 4 hours after gadolinium injection. *AJNR Am J Neuroradiol*. 2015;36(12):2367-2372. doi:10.3174/ajnr.A4439

67. Weinstein BE, Spitzer JB, Ventry IM. Test-retest reliability of the Hearing Handicap Inventory for the Elderly. *Ear Hear*. 1986;7(5):295-299. doi:10.1097/00003446-198610000-00002

68. Zazove P, Plegue MA, McKee MM, et al. Effective hearing loss screening in primary care: the Early Auditory Referral–Primary Care Study. *Ann Fam Med*. 2020;18(6):520-527. doi:10.1370/afm.2590

69. Kaplan-Neeman R, Muchnik C, Hildesheimer M, Henkin Y. Hearing aid satisfaction and use in the advanced digital era. *Laryngoscope*. 2012;122(9):2029-2036. doi:10.1002/lary.23404

70. McCormack A, Fortnum H. Why do people fitted with hearing aids not wear them? *Int J Audiol*. 2013;52(5):360-368. doi:10.3109/14992027.2013.769066

71. Wallhagen MI. The stigma of hearing loss. *Gerontologist*. 2010;50(1):66-75. doi:10.1093/geront/gnp107

72. Hickson L, Meyer C, Lovelock K, Lampert M, Khan A. Factors associated with success with hearing aids in older adults. *Int J Audiol*. 2014;53(suppl 1):S18-S27. doi:10.3109/14992027.2013.860488

73. Ferguson MA, Kitterick PT, Chong LY, Edmondson-Jones M, Barker F, Hoare DJ. Hearing aids for mild to moderate hearing loss in adults. *Cochrane Database Syst Rev*. 2017;9:CD012023. doi:10.1002/14651858.CD012023.pub2