

## Review | EVIDENCE REPORT FOR THE USPSTF

# Screening for Impaired Visual Acuity in Older Adults

## Updated Evidence Report and Systematic Review for the US Preventive Services Task Force

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**IMPORTANCE** Impaired visual acuity is common among older adults and can adversely affect function and quality of life.

**OBJECTIVE** To update a 2009 systematic review on screening for impaired visual acuity among older adults for the US Preventive Services Task Force (USPSTF).

**DATA SOURCES** Ovid MEDLINE (2008 to January 2016), Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews.

**STUDY SELECTION** Randomized clinical trials of screening; diagnostic accuracy studies of screening tests in primary care settings; and randomized clinical trials of treatment vs placebo or no treatment for uncorrected refractive errors, cataracts, and dry (atrophic) or wet (exudative) age-related macular degeneration (AMD). Studies of screening and diagnostic accuracy were limited to asymptomatic adults 65 years or older; studies of treatment included asymptomatic adults of any age.

**DATA EXTRACTION AND SYNTHESIS** One investigator abstracted data, a second checked data for accuracy, and 2 investigators independently assessed study quality using predefined criteria. Random-effects meta-analysis was used to estimate the relative and absolute benefits of vascular endothelial growth factor inhibitors (anti-VEGF) for wet AMD.

**MAIN OUTCOMES AND MEASURES** Visual acuity, vision-related function, functional capacity, harms, and diagnostic accuracy.

**RESULTS** Three trials (n = 4728) from the 2009 USPSTF review found that screening for impaired visual acuity was not associated with improved visual or clinical outcomes. In 1 good-quality trial (n = 3346), universal screening identified 27% of persons with impaired visual acuity and correctable impairment vs 3.1% with targeted screening, but there was no difference in the likelihood of visual acuity worse than 20/60 after 3 to 5 years (37% vs 35%; relative risk [RR], 1.07; 95% CI, 0.84-1.36). The 2009 review found that effective treatments are available for uncorrected refractive errors and cataracts. Ten-year trial results of dry AMD found an antioxidant/zinc combination was associated with decreased risk of visual acuity loss (46% vs 54%; odds ratio, 0.71; 95% CI, 0.57-0.88). An updated meta-analysis found anti-VEGF for wet AMD was associated with greater likelihood of having vision 20/200 or better vs sham injection (4 trials; RR, 1.47; 95% CI, 1.30-1.66;  $I^2 = 42%$ ; absolute risk difference, 24%; 95% CI, 12%-37% after 1 year). New evidence on the diagnostic accuracy of visual acuity screening tests was limited and consistent with previous findings that screening questions or a visual acuity test was associated with suboptimal accuracy.

**CONCLUSIONS AND RELEVANCE** Screening can identify persons with impaired visual acuity, and effective treatments are available for common causes of impaired visual acuity, such as uncorrected refractive error, cataracts, and dry or wet AMD. However, direct evidence found no significant difference between vision screening in older adults in primary care settings vs no screening for improving visual acuity or other clinical outcomes.

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**I**mpaired visual acuity refers to decreased clarity or sharpness of vision. Impaired visual acuity is associated with decreased function and quality of life and increased risk of falls and other accidental injuries.<sup>1-5</sup> The prevalence of impaired visual acuity increases with age.<sup>6,7</sup> Impaired visual acuity may be unreported or unrecognized in older persons because vision changes can be relatively subtle, progress slowly over time, or occur in persons with cognitive impairment.

The US Preventive Services Task Force (USPSTF) commissioned this review to update a 2009 review<sup>8,9</sup> and Recommendation Statement<sup>10</sup> on screening for impaired visual acuity due to uncorrected refractive errors, cataracts, and dry (atrophic) or wet (exudative) age-related macular degeneration (AMD). The USPSTF previously concluded that the evidence was insufficient to assess the balance of benefits and harms of screening for visual acuity for the improvement of outcomes in older adults (I statement).

### Scope of the Review

Using established methods,<sup>11</sup> the USPSTF determined the scope and key questions for this review. The final research plan was posted on the USPSTF website (<http://www.uspreventiveservicestaskforce.org/Page/Document/final-research-plan93/impaired-visual-acuity-in-older-adults-screening>) prior to conducting the review. The analytic framework and key questions (KQs) used to guide the review are shown in Figure 1.

Detailed methods and data for this review are contained in the full USPSTF review<sup>12</sup> (<http://www.uspreventiveservicestaskforce.org/Page/Document/final-evidence-review147/impaired-visual-acuity-in-older-adults-screening>), including search strategies, inclusion criteria, and abstraction tables; the full review also includes evidence on effectiveness of older treatments for wet AMD (laser photocoagulation and photodynamic therapy).

### Data Sources and Searches

Searches were conducted in Ovid MEDLINE, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews from 2008 (searches in the 2009 review were conducted through July 2008) to February 2015 (eAppendix 1 in the Supplement) and reference lists. An updated search conducted on January 6, 2016, using the same databases identified no new studies that would affect the conclusions or understanding of the evidence and therefore the related USPSTF recommendation.

### Study Selection

Two reviewers evaluated each study on the basis of predefined criteria. For studies on screening and diagnostic accuracy, we included studies of asymptomatic adults 65 years or older without known impaired visual acuity (based on current corrected vision) who have not sought care for evaluation of vision problems. We included randomized clinical trials (RCTs) of vision screening performed in primary care or community-based settings vs no screening, delayed screening, or usual care (eg, targeted screening) and evaluated visual acuity, vision-related quality of life, functional capacity, mortality, cognition, or harms. We included studies of diagnostic accuracy of vision screening tests, questions, or questionnaires performed in primary care or community settings. For treatment, we included RCTs of asymptomatic adults (not restricted to age  $\geq 65$  years) with mild to moderate vision impair-

ment (defined as best visual acuity worse than 20/40 but better than 20/200) that evaluated effects on the outcomes described above for corrective lenses, reading aids, or photorefractive surgery due to uncorrected refractive errors; vitamin and oxidants and vascular endothelial growth factor (VEGF) inhibitors for AMD; or cataract surgery. For screening and treatment, cohort studies were included when evidence from RCTs was insufficient. We excluded studies of screening and diagnostic testing performed in specialty settings and trials of treatment in patients with visual acuity worse than 20/200 or with other causes of vision loss. The selection of literature is summarized in Figure 2.

### Data Abstraction and Quality Assessment

Details about the study design, patient population, setting, screening method, interventions, analysis, and results were abstracted. Two investigators independently applied criteria developed by the USPSTF<sup>11</sup> to rate the quality of each study as good, fair, or poor (eAppendix 2 in the Supplement). Discrepancies were resolved through consensus.

### Data Synthesis and Analysis

The aggregate internal validity (quality) of the body of evidence for each KQ was assessed as good, fair, or poor using methods developed by the USPSTF,<sup>11</sup> based on the quality of studies, precision of estimates, consistency of results between studies, and directness of evidence.<sup>11</sup> Data synthesis was based on evidence from the 2009 review as well as new evidence. A meta-analysis on effectiveness of VEGF inhibitors vs placebo for wet AMD was performed using a random-effects model with Review Manager 5.2 (Nordic Cochrane Centre) to calculate pooled relative risks (RRs) and absolute risk differences. The meta-analysis was stratified by the VEGF inhibitor used. Results were considered statistically significant if the *P* value was less than .05 based on 2-sided testing, and statistical heterogeneity was measured using the *I*<sup>2</sup>.

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## Results

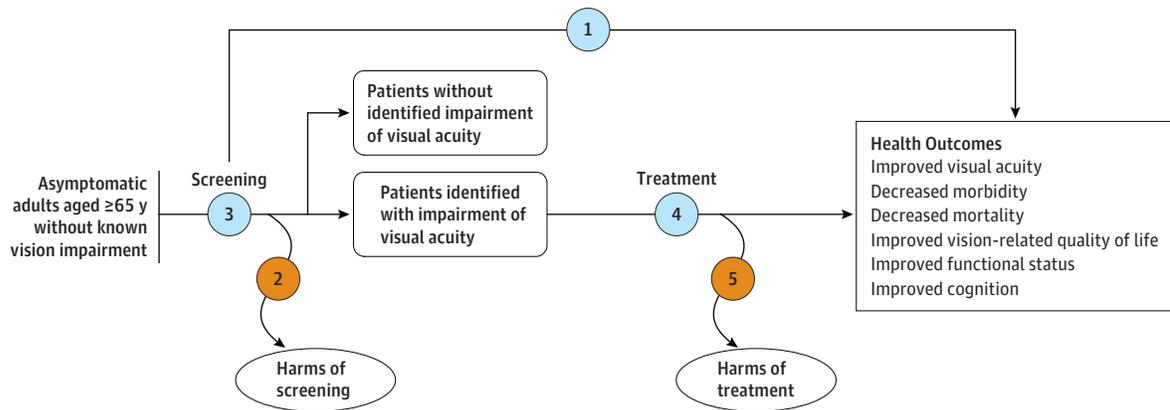
### Screening and Related Harms

**Key Question 1.** Does vision screening in asymptomatic older adults result in improved vision, morbidity or mortality, quality of life, functional status, or cognition?

**Key Question 2.** Are there harms of vision screening?

No new trials of vision screening were identified since 2008. Three cluster randomized trials (*n* = 4728) of vision screening performed as part of a multicomponent screening intervention in older adults (mean age, 76-81 years) were included in the 2009 USPSTF review<sup>8</sup> (Table 1 and eTable 1 in the Supplement). The trials found no difference between vision screening vs no vision screening, usual care, or delayed screening on vision and other clinical outcomes after follow-up of 6 months to 5 years.<sup>13-15</sup> In the highest-quality and largest trial (*n* = 3346),<sup>15</sup> universal vision screening identified a greater percentage of patients with impaired visual acuity and correctable impairment (27%) than did targeted screening (3.1%), yet there was no difference in likelihood of visual acuity worse than 20/60 after 3- to 5-year follow-up (37% vs 35%; relative risk [RR], 1.07; 95% CI, 0.84-1.36). In this trial, 18 of 40 patients (45%) advised to see an optician after vision screening actually received new

Figure 1. Analytic Framework and Key Questions



## Key questions

- 1 Does vision screening in asymptomatic older adults result in improved vision, morbidity or mortality, quality of life, functional status, or cognition?
- 2 Are there harms of vision screening?
- 3 What is the accuracy of screening for early impairment in visual acuity due to uncorrected refractive error, cataracts, or age-related macular degeneration?
- 4 Does treatment of early impairment in visual acuity due to uncorrected refractive error, cataracts, or age-related macular degeneration lead to improved visual acuity, morbidity, mortality, vision-related quality of life, functional status, or cognition?
- 5 Are there harms of treating early impairment in visual acuity?

"Asymptomatic" individuals are those without known impaired visual acuity (based on current corrected vision) who have not sought care for evaluation of vision problems.

lenses and 41 of 75 persons (55%) eligible for referral to an ophthalmologist had clear evidence of a referral, which could have attenuated potential benefits. Other reasons for lack of benefit in the screening trials may include the high loss to follow-up in all trials, similar frequency of vision disorder detection and treatment in the screening and control groups in 1 trial,<sup>14</sup> use of a screening question to identify persons for further testing in 1 trial,<sup>14</sup> and low uptake of recommended interventions in 1 trial.<sup>13</sup> No study addressed harms of vision screening.

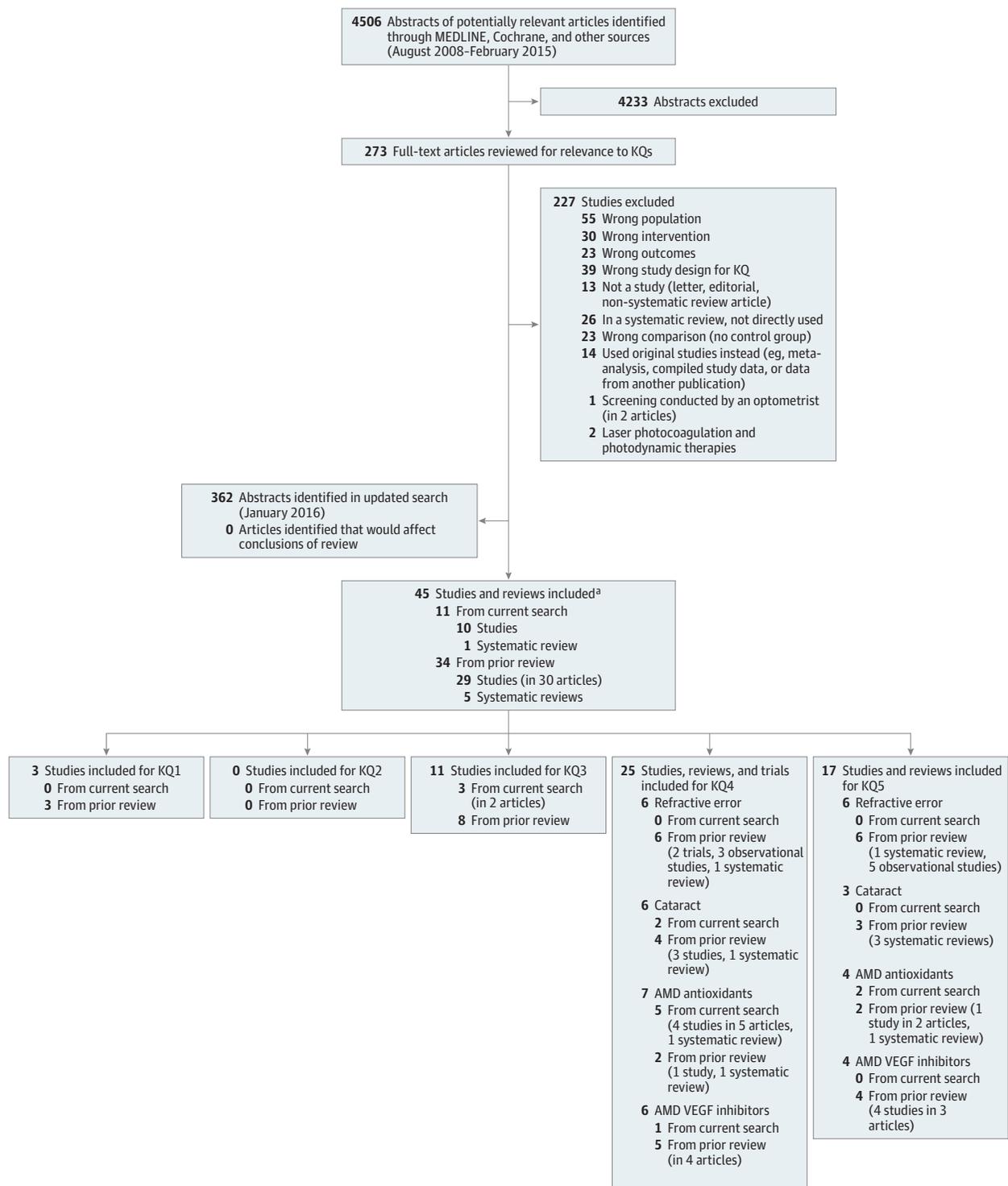
One additional screening trial did not meet inclusion criteria because it was conducted in a specialty setting.<sup>16</sup> It found vision screening by an optometrist in frail elderly persons increased the risk for falls (2.45 falls/patient vs 1.68 falls/patient; rate ratio, 1.57; 95% CI, 1.20-2.05) along with a non-statistically significant increased risk for fractures (10% vs 5.7%; RR, 1.74; 95% CI, 0.97-3.11) after 1 year compared with usual care.<sup>16</sup> Screening led to new eyeglasses or referral for further treatment for 47% of study participants. A subsequent report from this study also found no difference between groups in improvement in vision or vision-related quality of life after 1 year.<sup>17</sup>

## Accuracy of Screening

**Key Question 3.** What is the accuracy of screening for early impairment in visual acuity due to uncorrected refractive error, cataracts or age-related macular degeneration?

The 2009 USPSTF review<sup>8</sup> included 8 cross-sectional studies on the diagnostic accuracy of screening for impaired visual acuity in older adults (Table 2 and eTable 2 in the Supplement).<sup>18-25</sup> Four studies found screening questions or questionnaires had low accuracy for identifying persons with impaired visual acuity compared with the Snellen eye chart<sup>19,20,23</sup> or an ophthalmologic examination.<sup>24</sup> Positive likelihood ratios ranged from 1.19 to 3.23 and negative likelihood ratios ranged from 0.23 to 0.78. Four studies<sup>18,21,24,25</sup> found no visual acuity test had both high sensitivity and specificity compared with a detailed ophthalmologic examination, resulting in positive likelihood ratios that ranged from 1.00 to 8.07 and negative likelihood ratios that ranged from 0.32 to 1.00. Two studies reported areas under the receiver operating characteristic curves of 0.66 and 0.83.<sup>18,21</sup> One study found the Amsler grid had poor accuracy for identifying visual conditions (positive likelihood ratio 1.65 and negative likelihood

Figure 2. Literature Flow Diagram



Cochrane databases include the Cochrane Central Register of Controlled Trials and the Cochrane Database of Systematic Reviews. Other sources include prior reviews, references lists, and referrals from experts. AMD indicates age-related macular degeneration; VEGF, vascular endothelial growth factor.

<sup>a</sup> Studies and reviews may be included for more than 1 key question (KQ).

Table 1. Trials of Screening for Impaired Visual Acuity in Older Adults (Key Question 1)

Source	Country <sup>a</sup>	Setting	Female, No./Total No. (%)	Mean Age, y	Baseline Visual Acuity	Intervention	Results	Quality <sup>b</sup>
Eekhof et al, <sup>13</sup> 2000	The Netherlands	General practice	717/1121 (64)	81	NR	G1, screening: Snellen eye chart and/or functional visual assessment G2, delayed screening	G1 vs G2: Vision problem detected: 49% vs NR Visual disorder in second year: 51% (95% CI, 45%-58%) vs 47% (95% CI, 42%-52%); P = .68	Fair
Moore et al, <sup>14</sup> 1997	United States	Community-based office practice	161/261 (62)	76	NR	G1, screening: question to assess difficulty performing everyday activities, followed by Snellen eye chart if positive G2, usual care	G1 vs G2: Vision problem detected: 20% vs 19% Improvement in vision at 6 mo: 20% (20/99) vs 24% (31/131); RR, 0.85 (95% CI, 0.52-1.40)	Fair
Smeeth et al, <sup>15</sup> 2003	United Kingdom	General practice	2065/3346 (62)	80	Difficulty seeing newsprint: G1, 8%; G2, 10%	G1, universal screening: health assessment by a trained nurse, including Glasgow eye chart and pinhole testing if visual acuity <6/18 in either eye G2, targeted screening: brief health assessment	G1 vs G2: Found to have visual acuity <6/18 in either eye: 27% (451/1662) vs 3.1% (53/1684) Visual acuity <6/18 (20/60) at 3 y: RR, 1.07 (95% CI, 0.84 to 1.36) Mean NEI-VFQ composite score: 86.0 vs 85.6 (range, 1-100); mean difference, 0.4 (95% CI, -1.7 to 2.5)	Good

Abbreviations: G1, G2, group 1, group 2; NEI-VFQ, National Eye Institute Vision Function Questionnaire; NR, not reported; RCT, randomized clinical trial; RR, relative risk.

<sup>a</sup> Race was not reported in any of the 3 trials.

<sup>b</sup> See eTable 1 in the Supplement for detailed quality assessment.

ratio 0.91).<sup>18</sup> A study published in 1988 (n = 50) reported that 100% of patients with cataract and 75% of patients with AMD were correctly identified by a geriatrician compared with an ophthalmologist, with no false positives.<sup>22</sup>

Three fair-quality cross-sectional studies (reported in 2 publications) published subsequent to the 2009 review evaluated the diagnostic accuracy of screening tests in primary care settings (Table 2 and eTable 2 in the Supplement).<sup>26,27</sup> Two studies (n = 180 and 200) found that a computerized vision screening tool or a flip chart version of the test were not accurate compared with a detailed eye examination.<sup>26</sup> Optimal sensitivity (0.80) and specificity (0.68) were observed with the combination of abnormal high-contrast visual acuity (threshold >0.19 logarithm of the minimal angle of resolution) or abnormal near visual acuity, resulting in a positive likelihood ratio of 2.5 and a negative likelihood ratio of 0.29. The flip chart instrument performed similarly, based on the low-contrast visual acuity test alone (sensitivity 0.75 and specificity 0.77, for a positive likelihood ratio of 3.26 and negative likelihood ratio of 0.32). A third study (n = 371) compared the scores on the Minimum Data Set (MDS) 2.0 Vision Patterns section against a standard visual acuity test (Early Treatment Diabetic Retinopathy Study chart) for detecting impaired visual acuity.<sup>27</sup> Diagnostic accuracy was poor. Using a cutoff score of 1 or greater (0 indicating adequate vision and scores of 1-3 various degrees of impairment), sensitivity of the MDS Visual Patterns section for detecting visual acuity worse than 20/40 was 0.52 and specificity 0.75, for a positive likelihood ratio of 2.11 and a negative likelihood ratio of 0.64.

## Treatment

**Key Question 4.** Does treatment of early impairment in visual acuity due to uncorrected refractive error, cataracts, or AMD lead to improved visual acuity, morbidity, mortality, vision-related quality of life, functional status, or cognition?

## Uncorrected Refractive Error

We identified no new study of treatment vs no treatment for mild uncorrected refractive errors on vision, vision-related quality life, or functional outcomes. The 2009 USPSTF review<sup>8</sup> found that refractive lenses and refractive surgery<sup>28</sup> were highly effective at restoring normal or near-normal visual acuity, based on a large body of observational data and accumulated clinical experience. It also included 2 randomized trials that reported beneficial effects of corrective lenses on vision-related quality of life, but not in functional status.<sup>29,30</sup> A later report from 1 of these studies,<sup>30</sup> published subsequent to the 2009 USPSTF review, also found no effects on function or cognitive status<sup>31</sup>; however, 3 observational studies found refractive surgery was associated with improved quality of life.<sup>32-34</sup>

## Cataracts

The 2009 USPSTF review<sup>8</sup> found that more than 90% of patients undergoing cataract surgery achieved visual acuity of 20/40 or better based on observational studies.<sup>35</sup> It also included 1 trial that found immediate cataract surgery (within 4 weeks) decreased the risk of falls compared with routine surgery (12 months' wait): 1.00/1000 patient days vs 1.52/1000 patient days (rate ratio, 0.66; 95% CI, 0.40-0.96).<sup>36</sup> Two cohort studies that were not in the 2009 USPSTF review found no association of cataract surgery vs no surgery with cognitive function or quality of life after 4 months<sup>31</sup> and 1 year,<sup>37</sup> although visual acuity improved after surgery in both studies.

## Dry AMD

The 2009 USPSTF review<sup>8</sup> included 1 large, good-quality (n = 2556) randomized trial, the Age-Related Eye Disease Study (AREDS) study.<sup>38</sup> AREDS reported results stratified according to the severity of AMD at baseline. Among the subgroup of patients in whom treatment is currently recommended (AREDS categories

Table 2. Studies of Diagnostic Accuracy for Impaired Visual Acuity in Older Adults (Key Question 3)<sup>a</sup>

Source	Sample Size	Reference Standard	Target Vision Condition	Screening Test	Sensitivity (95% CI)	Specificity (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Diagnostic OR (95% CI) <sup>b</sup>
<b>Studies From Update</b>									
Jessa et al, <sup>26</sup> 2012 (study 1)	180	"Gold standard eye examination" <sup>c</sup>	Any ocular disease	High-contrast visual acuity >0.19 logMAR or abnormal near visual acuity	0.80 (0.72-0.86)	0.68 (0.57-0.77)	2.48 (1.76-3.49)	0.29 (0.20-0.45)	8.55
Jessa et al, <sup>26</sup> 2012 (study 2)	200	"Gold standard eye examination" <sup>c</sup>	Any ocular disease	A: High-contrast visual acuity >0.9 logMAR or abnormal near visual acuity B: Low-contrast visual acuity >0.49 logMAR	A: 0.75 (0.67-0.82) B: 0.75 (0.67-0.82)	A: 0.69 (0.58-0.78) B: 0.77 (0.66-0.85)	A: 2.45 (1.78-3.36) B: 3.26 (2.24-4.76)	A: 0.36 (0.25-0.51) B: 0.32 (0.22-0.46)	A: 6.81 B: 10.3
Swanson et al, <sup>27</sup> 2009	371	ETDRS chart	Any ocular disease	MDS vision patterns section score >0 (adequate)	0.52 (0.45-0.59)	0.75 (0.68-0.82)	2.11 (1.56-2.86)	0.64 (0.54-0.75)	3.30
<b>Studies From 2009 Review</b>									
<b>Amsler grid</b>									
Ariyasu et al, <sup>18</sup> 1996	317	Ophthalmologic examination	Any ocular disease, excluding refractive error	Amsler grid abnormal	0.20 (0.14-0.27)	0.88 (0.80-0.94)	1.65 (0.90-3.06)	0.91 (0.82-1.01)	1.82 (0.90-3.69)
<b>Physical examination</b>									
McMurdo and Baines, <sup>22</sup> 1988	50	Ophthalmologist examination	A: Cataract B: AMD	Positive finding on physical examination	A: 1.0 (9/9) B: 0.75 (3/4)	A: 1.0 (41/41) B: 1.0 (46/46)	NC	NC	NC
<b>Screening questions</b>									
Eekhof et al, <sup>19</sup> 2000	1121	Snellen chart	Visual acuity ≤0.3 (about 20/60 on Snellen)	Trouble recognizing face by questionnaire	0.60 (0.51-0.69)	0.82 (0.79-0.84)	3.23 (2.66-3.93)	0.49 (0.40-0.61)	6.56 (4.42-9.72)
			Difficulty with low vision chart at reading distance	Trouble reading newspaper by questionnaire	0.83 (0.76-0.88)	0.67 (0.64-0.70)	2.47 (2.20-2.78)	0.26 (0.18-0.37)	9.45 (6.08-14.7)
Hiller and Krueger, <sup>20</sup> 1983	3997	Snellen chart	A: Visual acuity ≤20/50 B: Visual acuity ≤20/100	Trouble seeing by questionnaire	A: 0.34 (0.28-0.41) B: 0.48 (0.32-0.63)	A: 0.84 (0.82-0.86) B: 0.82 (0.80-0.84)	A: 2.15 (1.72-2.69) B: 2.69 (1.94-3.74)	A: 0.78 (0.71-0.86) B: 0.64 (0.48-0.84)	A: 2.75 (2.00-3.78) B: 4.24 (2.33-7.72)
Chu-Ai Teh et al, <sup>23</sup> 2006	124	Snellen chart	Visual acuity ≤20/40	Problem with vision by questionnaire	0.68 (0.58-0.78)	0.43 (0.22-0.66)	1.19 (0.80-1.77)	0.74 (0.42-1.33)	1.60 (0.62-4.16)
Wang et al, <sup>24</sup> 1998	405	Ophthalmologic examination	Any ocular disease	A: Problem with vision by questionnaire B: Problem with vision by questionnaire followed by visual acuity ≤20/40	A: 0.90 (0.85-0.94) B: 0.57 (0.50-0.64)	A: 0.44 (0.37-0.51) B: 0.79 (0.73-0.84)	A: 1.60 (1.41-1.83) B: 2.72 (2.03-3.65)	A: 0.23 (0.15-0.36) B: 0.54 (0.46-0.65)	A: 6.88 (4.06-11.7) B: 5.00 (3.23-7.74)

(continued)

Table 2. Studies of Diagnostic Accuracy for Impaired Visual Acuity in Older Adults (Key Question 3)<sup>a</sup> (continued)

Source	Sample Size	Reference Standard	Target Vision Condition	Screening Test	Sensitivity (95% CI)	Specificity (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Diagnostic OR (95% CI) <sup>b</sup>
Visual acuity testing									
Ariyasu et al, <sup>18</sup> 1996	317	Ophthalmologic examination	Any ocular disease, excluding refractive error	Near visual acuity ≤20/30	0.83 (0.75-0.89)	0.32 (0.23-0.44)	1.23 (1.04-1.46)	0.52 (0.32-0.86)	2.34 (1.23-4.47)
				Near visual acuity ≤20/40	0.76 (0.68-0.83)	0.49 (0.38-0.61)	1.50 (1.19-1.90)	0.49 (0.33-0.71)	3.09 (1.71-5.55)
				Near visual acuity ≤20/60	0.60 (0.52-0.69)	0.64 (0.53-0.74)	1.67 (1.22-2.30)	0.62 (0.47-0.81)	2.70 (1.53-4.77)
Ariyasu et al, <sup>18</sup> 1996	317	Ophthalmologic examination	Any ocular disease, excluding refractive error	Presenting distance visual acuity ≤20/30	0.75 (0.69-0.81)	0.51 (0.42-0.61)	1.54 (1.26-1.90)	0.48 (0.36-0.65)	3.18 (1.96-5.18)
				Presenting distance visual acuity ≤20/40	0.68 (0.61-0.74)	0.67 (0.58-0.76)	2.08 (1.57-2.76)	0.47 (0.37-0.60)	4.40 (2.69-7.18)
				Presenting distance visual acuity ≤20/60	0.53 (0.46-0.60)	0.86 (0.78-0.92)	3.76 (2.34-6.03)	0.54 (0.46-0.64)	6.90 (3.82-12.5)
Ivers et al, <sup>21</sup> 2001	3654	Ophthalmologic examination	A: Nuclear cataract B: Early AMD C: Any eye disease	Pinhole distance acuity ≤20/30	A:	A:	A:	A:	A:
					B:	B:	B:	B:	B:
					C:	C:	C:	C:	C:
				Pinhole distance acuity ≤20/40	A:	A:	A:	A:	A:
					B:	B:	B:	B:	B:
					C:	C:	C:	C:	C:
				Pinhole distance acuity ≤20/60	A:	A:	A:	A:	A:
					B:	B:	B:	B:	B:
					C:	C:	C:	C:	C:
Ivers et al, <sup>21</sup> 2001	3654	Ophthalmologic examination	A: Nuclear cataract B: Early AMD C: Any eye disease	Presenting distance visual acuity ≤20/30	A:	A:	A:	A:	A:
					B:	B:	B:	B:	B:
					C:	C:	C:	C:	C:
				Presenting distance visual acuity ≤20/40	A:	A:	A:	A:	A:
					B:	B:	B:	B:	B:
					C:	C:	C:	C:	C:
				Presenting distance visual acuity ≤20/60	A:	A:	A:	A:	A:
					B:	B:	B:	B:	B:
					C:	C:	C:	C:	C:

(continued)

Table 2. Studies of Diagnostic Accuracy for Impaired Visual Acuity in Older Adults (Key Question 3)<sup>a</sup> (continued)

Source	Sample Size	Reference Standard	Target Vision Condition	Screening Test	Sensitivity (95% CI)	Specificity (95% CI)	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Diagnostic OR (95% CI) <sup>b</sup>
Visual acuity testing (continued)									
Ivers et al, <sup>21</sup> 2001	3654	Ophthalmologic examination	A: Nuclear cataract B: Early AMD C: Any eye disease	Reading acuity ≤20/30	A: 0.97 (0.96-0.98)	A: 0.03 (0.02-0.04)	A: 1.00 (0.99-1.01)	A: 1.00 (0.63-1.60)	A: 1.00 (0.62-1.61)
					B: 0.99 (0.96-1.00)	B: 0.03 (0.02-0.04)	B: 1.02 (1.00-1.04)	B: 0.42 (0.10-1.69)	B: 2.42 (0.65-8.98)
					C: 0.98 (0.97-0.99)	C: 0.03 (0.02-0.04)	C: 1.01 (1.00-1.02)	C: 0.66 (0.42-1.03)	C: 1.53 (0.97-2.42)
				Reading acuity ≤20/40	A: 0.88 (0.86-0.90)	A: 0.20 (0.18-0.22)	A: 1.10 (1.06-1.14)	A: 0.60 (0.49-0.73)	A: 1.84 (1.46-2.32)
					B: 0.95 (0.90-0.98)	B: 0.16 (0.15-0.17)	B: 1.13 (1.09-1.18)	B: 0.32 (0.16-0.62)	B: 3.59 (1.78-7.26)
					C: 0.89 (0.87-0.91)	C: 0.19 (0.18-0.21)	C: 1.10 (1.07-1.13)	C: 0.58 (0.49-0.68)	C: 1.90 (1.55-2.32)
				Reading acuity ≤20/60	A: 0.57 (0.54-0.60)	A: 0.59 (0.56-0.62)	A: 1.39 (1.28-1.52)	A: 0.73 (0.67-0.79)	A: 1.91 (1.62-2.26)
					B: 0.70 (0.62-0.77)	B: 0.53 (0.51-0.55)	B: 1.48 (1.33-1.65)	B: 0.57 (0.45-0.72)	B: 2.61 (1.85-3.68)
					C: 0.59 (0.56-0.62)	C: 0.59 (0.57-0.61)	C: 1.44 (1.35-1.54)	C: 0.70 (0.64-0.75)	C: 2.07 (1.80-2.38)
Wang et al, <sup>24</sup> 1998	405	Ophthalmologic examination	Any ocular disease	Presenting distance visual acuity ≤20/40	0.61 (0.54-0.68)	0.72 (0.65-0.78)	2.18 (1.70-2.79)	0.54 (0.45-0.66)	4.02 (2.65-6.09)
Woods et al, <sup>25</sup> 1998	3283	Ophthalmologic examination	Any ocular disease, excluding refractive error	Near visual acuity ≤20/30	0.77 (0.74-0.80)	0.68 (0.63-0.73)	2.41 (2.08-2.80)	0.34 (0.30-0.38)	7.15 (5.52-9.26)
Woods et al, <sup>25</sup> 1998	3283	Ophthalmologic examination	Any ocular disease, excluding refractive error	Presenting distance visual acuity ≤20/30	0.74 (0.71-0.77)	0.87 (0.83-0.90)	5.66 (4.36-7.34)	0.30 (0.27-0.33)	18.9 (13.6-26.3)

Abbreviations: AMD, age-related macular degeneration; ETDRS, Early Treatment Diabetic Retinopathy Study; logMAR, logarithm of the minimal angle of resolution; MDS, Minimum Data Set; NC, not calculated; OR, odds ratio.

<sup>b</sup> Diagnostic OR is the ratio of the positive likelihood ratio to the negative likelihood ratio.

<sup>a</sup> All studies had a cross-sectional design. See eTable 2 in the Supplement for detailed quality assessment.

<sup>c</sup> Included computerized high-contrast visual acuity and low-contrast visual acuity tests.

3 and 4), AREDS found an antioxidant and zinc combination effective for lower likelihood of AMD progression after 6 years of follow-up (adjusted odds ratio [OR], 0.66; 95% CI, 0.47-0.93), although the difference in the likelihood of losing 15 or more letters of visual acuity was not statistically significant (adjusted OR, 0.75; 95% CI, 0.55-1.02). Ten-year follow-up results from AREDS are now available and are consistent with prior results; antioxidant supplements alone (OR, 0.70; 95% CI, 0.56-0.88) or with added zinc (OR, 0.66; 95% CI, 0.53-0.83) were associated with decreased risk of AMD progression vs placebo among persons with AREDS categories 3 and 4 AMD, and the combination was associated with decreased risk of visual acuity loss (46% vs 54%; OR, 0.71; 95% CI, 0.57-0.88).<sup>39</sup> The rates of AMD progression were 34% with the combination and 44% with placebo. Mortality outcomes were reported for AREDS severity categories 2, 3, and 4 (n = 3476). Zinc was also associated with a significantly decreased risk of all-cause mortality (22% vs 25%; adjusted HR, 0.83; 95% CI, 0.73-0.95) and cardiovascular mortality (adjusted RR, 0.80; 95% CI, 0.64-0.99), but there was no significant decrease in cancer mortality risk (adjusted RR, 0.84; 95% CI, 0.65-1.08).

A smaller, good-quality trial (n = 300) published since the 2009 USPSTF review found no difference between daily supplementation with fish oil capsules vs placebo in risk of visual acuity loss of 15 or more letters after 3 years (17.8% vs 16.3%; RR, 1.25; 95% CI, 0.69-2.26), although fish oil was associated with decreased risk of developing cataracts, worsening cataract, or need for cataract surgery (50.0% vs 62.5%; RR, 0.80; 95% CI, 0.64-0.99).<sup>40</sup> (RRs and CIs calculated based on proportions reported in the original article.<sup>40</sup>) Evidence on other vitamins and minerals for dry AMD remains limited, with no clear effects on AMD progression or visual acuity (Table 3, Table 4, and eTable 3 in the Supplement).<sup>41-44</sup>

#### Wet AMD

The 2009 USPSTF review<sup>8</sup> included 4 good-quality trials (reported in 3 publications, n = 184 to 716) of intravitreal injection with VEGF inhibitors vs sham therapy.<sup>45-47</sup> In the 2009 USPSTF review, pooled results were reported separately for pegaptanib (2 trials) and ranibizumab (2 trials); both VEGF inhibitors were associated with better visual acuity outcomes vs sham injections. A meta-analysis based on all 4 of these trials found VEGF inhibitors associated with greater likelihood for a gain of 15 or more letters in visual acuity (RR, 2.92; 95% CI, 1.20 to 7.12;  $I^2 = 76%$ ), but the absolute risk difference was not statistically significant (10%; 95% CI, -7% to 27%). VEGF inhibitors were associated with greater likelihood of having vision 20/200 or better vs sham injection (RR, 1.47; 95% CI, 1.30 to 1.66;  $I^2 = 42%$ ; absolute risk difference, 24%; 95% CI, 12% to 37%) after 1 year (Figure 3 and Figure 4). Beneficial effects were also observed in the MARINA trial after 2 years.<sup>45</sup> One trial each found intravitreal injection with VEGF inhibitors was associated with small improvements in likelihood of driving among those driving at baseline<sup>48</sup> and in vision-related function.<sup>49</sup>

The MARINA trial found no difference between ranibizumab vs placebo in all-cause mortality (2% vs 3%; RR, 0.91; 95% CI, 0.34-2.44) or vascular mortality (1% vs 2%; RR, 0.74; 95% CI, 0.21-2.60) after 2 years.<sup>45</sup> In the other trials, there were no deaths<sup>47</sup> or mortality was not reported.<sup>46</sup>

## Harms of Treatment

**Key Question 5.** Are there harms of treating early impairment in visual acuity?

#### Refractive Error

We identified no new study on harms of treatment for uncorrected refractive error compared with no treatment. The 2009 USPSTF review<sup>8</sup> included 1 small study (n = 156) that reported a higher risk of falls in older adults using multifocal lenses compared with unifocal lenses (48% vs 37%; adjusted OR, 2.29; 95% CI, 1.06-4.92).<sup>50</sup> Three studies reported that incidence of keratitis ranged from 0.3 to 3.6 cases per 10 000 contact lens wearers.<sup>51-53</sup> A meta-analysis reported rates of corneal ectasia of 0% to 0.87% based on 5 studies of laser-assisted in situ keratomileusis (LASIK) and rates of keratitis of 0% to 3.4% based on 6 studies of LASIK and 4 studies of laser-assisted subepithelial keratomileusis (LASEK).<sup>28</sup>

#### Cataract

We identified no new study of harms of cataract surgery vs no surgery. The 2009 USPSTF review included 3 systematic reviews<sup>35,54,55</sup> of observational studies on harms of cataract surgery, which reported pooled rates of posterior lens opacification of 28% after 5 years and 0.13% for endophthalmitis.

#### AMD

We identified no new studies on harms of treatment for AMD vs no treatment. The 2009 USPSTF review<sup>8</sup> found use of antioxidant vitamins and mineral supplements not associated with increased risk of most adverse events.<sup>41</sup> One trial published subsequent to the 2009 USPSTF review found no difference between supplement use vs placebo in risk of any adverse events (93% vs 89%; RR, 1.05; 95% CI, 0.97-1.13), serious adverse events (31% vs 30%; RR, 1.04; 95% CI, 0.72-1.49), or serious ocular adverse events (8.2% vs 7.0%; RR, 1.18; 95% CI, 0.50-2.75)<sup>40</sup>; one other trial published subsequent to the 2009 USPSTF review found no difference in risk of withdrawals due to adverse events (7.1% vs 2.3%; RR, 3.00; 95% CI, 0.33-28).<sup>43</sup> One of 2 trials found VEGF inhibitors associated with greater likelihood of withdrawal vs sham therapy<sup>45,46</sup>; there were no differences in serious or other adverse events, but estimates for those outcomes were imprecise.

## Discussion

Table 5 summarizes the evidence reviewed for this update. We identified no new trials of vision screening vs no screening, delayed screening, or usual care. Three fair- to good-quality cluster randomized trials included in the 2009 USPSTF review<sup>8</sup> that enrolled more than 4700 patients found vision screening in older adults as part of a multicomponent screening intervention in primary care settings to be no more effective than no vision screening, delayed screening, or usual care.<sup>13-15</sup> A fourth trial found optometrist screening associated with an increased risk of falls in frail elderly individuals.<sup>16</sup>

Conclusions regarding the suboptimal diagnostic accuracy of vision screening tests in primary care settings are also unchanged from the 2009 USPSTF review. Two new studies found that the accuracy of a computer-based screening tool was limited,

**Table 3. Treatment Studies of Antioxidant Vitamins, Minerals, and Other Supplements for Dry AMD Published Since the 2009 Review: Systematic Review (n = 6150 Participants) (Key Question 4)**

Source	Comparison	Databases Searched, Date of Last Search	No. and Design of Studies	Interventions	Methods for Rating Methodological Quality of Primary Studies	Methods for Synthesizing Results of Primary Studies	Results	Adverse Events	Quality
Evans et al, <sup>42</sup> 2012	Antioxidant vitamin or mineral supplementation vs placebo/no intervention	MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, Allied and Complementary Medicine Database, OpenGrey, metaRegister of Controlled Trials, ClinicalTrials.gov through August 2012	13 RCTs: zinc (5 trials), lutein (2 trials), vitamin E (1 trial), antioxidant combination (4 trials); multiple interventions (1 trial)	A: Antioxidant vitamin or mineral supplementation A1: Multivitamin or mineral supplement A2: Zinc B: Placebo/no intervention	Risk of bias assessment using criteria from Cochrane Handbook for Systematic Review Interventions (2011)	For dichotomous outcomes, calculated RRs and standard error and converted reported ORs to RRs when possible. Random-effects model used assessing SMD for continuous outcomes. If $\leq 3$ trials, fixed-effects model was used.	<p><b>A vs B (SMD):</b> Visual acuity, loss of <math>\geq 3</math> lines (3 trials): OR, 0.81; 95% CI, 0.67 to 0.98 Mean visual acuity (4 trials): no meta analysis; SMD range, -0.80 to 0.14; CI significant for 1 study (SMD, -0.80; 95% CI, -1.27 to -0.32) Mean change in visual acuity (3 trials): no meta analysis; SMD range, -0.34 to 0.42; CI not significant for any trial AMD progression, dichotomous: no meta analysis; OR ranged from 0.50 to 2.31; CI not significant for any trial</p> <hr/> <p><b>A1 vs B:</b> Mean visual acuity (2 trials): SMD, 0.00; 95% CI, -0.45 to 0.45 Mean change in visual acuity (2 trials): SMD, 0.34; 95% CI, -0.10 to 0.79 AMD progression, continuous (2 trials): no meta-analysis conducted; results from individual trials found no significant difference AMD progression, dichotomous (1 trial): adjusted OR (for ages, sex, smoking, and AMD category), 0.68; 95% CI, 0.53 to 0.87</p> <hr/> <p><b>A2 vs B:</b> Visual acuity, loss of <math>\geq 3</math> lines (2 trials): OR, 0.81; 95% CI, 0.66 to 0.99 Mean visual acuity (1 trial): SMD, 0.15; 95% CI, -0.29 to 0.60 Mean change in visual acuity (1 trial): SMD, -0.34; 95% CI, -0.79 to 0.11 AMD progression, dichotomous (3 trials): OR, 0.73; 95% CI, 0.58 to 0.93</p>	No meta-analysis; narrative review suggested higher rates of withdrawals due to adverse events in participants taking zinc vs placebo. Other harms not well reported.	Good

Abbreviations: AMD, age-related macular degeneration; OR, odds ratio; RCT, randomized clinical trial; RR, risk ratio; SMD, standardized mean difference.

**Table 4. Treatment Studies of Antioxidant Vitamins, Minerals, and Other Supplements for Dry AMD Published Since the 2009 Review: Trials (Key Question 4)<sup>a</sup>**

Source	Sample Size	Interventions and Follow-up	Age, y	Female	Race	Clinical Factors	Vision-Related Outcomes	Other Outcomes	Adverse Events
Chew et al, <sup>39</sup> 2013 (AREDS report No. 35)	n = 4753 <sup>b</sup>	A: Antioxidant supplement (vitamin C, 500 mg + vitamin E, 400 IU + beta-carotene, 15 mg/d) B: Zinc, 80 mg/d C: Antioxidant supplement + zinc D: Placebo Follow-up: 10 y	Median A: 6 B: 70 C: 69 D: 69 <sup>c</sup>	A: 55% B: 57% C: 56% D: 56% <sup>c</sup>	A: 97% white, 2% black, 1% other B: 96% white, 3% black, 1% other C: 97% white, 3% black, <1% other D: 96% white, 4% black, <1% other <sup>c</sup>	AMD category A: 28% category 2, 40% category 3, 24% category 4 B: 30% category 2, 41% category 3, 22% category 4 C: 28% category 2, 42% category 3, 22% category 4 D: 30% category 2, 40% category 3, 22% category 4	A vs D: <sup>d</sup> Loss of visual acuity ≥15 letters ETDRS: OR, 0.83; 95% CI, 0.67-1.02 Visual acuity <20/100: OR, 0.82; 95% CI, 0.64-1.07 Progression to advanced AMD: OR, 0.70; 95% CI, 0.56-0.88 B vs D: <sup>d</sup> Loss of visual acuity ≥15 letters ETDRS: OR, 0.86; 95% CI, 0.70-1.07 Visual acuity <20/100: OR, 0.88; 95% CI, 0.69-1.14 Progression to advanced AMD: OR, 0.82; 95% CI, 0.66-1.02 C vs D: <sup>d</sup> Loss of visual acuity ≥15 letters ETDRS: OR, 0.71; 95% CI, 0.57-0.88 Visual acuity <20/100: OR, 0.72; 95% CI, 0.56-0.94 Progression to advanced AMD: OR, 0.66; 95% CI, 0.53-0.83	A + C (antioxidant) vs B + D (no antioxidant): <sup>e</sup> All-cause mortality: 24.0% (439/1831) vs 23.6% (427/1806); aHR, <sup>f</sup> 1.06; 95% CI, 0.93-1.21 CV mortality: aRR, <sup>f</sup> 1.20; 95% CI, 0.97-1.49 Cancer mortality: aRR, 1.07; 95% CI, 0.83-1.38 Non-CV, noncancer mortality: aRR, 0.94; 95% CI, 0.74-1.20 B + C (zinc) vs A + D (no zinc): <sup>e</sup> All-cause mortality: 22.4% (401/1790) vs 25.2% (465/1847); aHR, 0.83; 95% CI, 0.73-0.95 CV mortality: aRR, 0.80; 95% CI, 0.64-0.99 Cancer mortality: aRR, 0.84; 95% CI, 0.65-1.08 Non-CV, noncancer mortality: aRR, 0.93; 95% CI, 0.73-1.18	NR by treatment group; narrative report of no significant increase in incidence of hospitalization after adjustment for age, sex, smoking, and treatment group
Ma et al, <sup>44</sup> 2012	n = 108	A: Lutein, 10 mg/d B: Lutein, 20 mg/d C: Lutein, 10 mg/d + zeaxanthin, 10 mg/d D: Placebo Follow-up: 48 wk	Mean A: 70 B: 69 C: 69 D: 69	A: 62% B: 56% C: 56% D: 60%	NR	BCVA (logMAR) A: 0.30 B: 0.28 C: 0.28 D: 0.31 Nonsmoker A: 89% B: 89% C: 85% D: 89%	A vs D: BCVA, mean change from baseline: -0.04 (95% CI, -0.11 to 0.03) vs -0.00 (95% CI, -0.06 to 0.05); P = NS B vs D: BCVA, mean change from baseline: -0.02 (95% CI, -0.11 to 0.06) vs -0.00 (95% CI, -0.06 to 0.05); P = NS C vs D: BCVA, mean change from baseline: -0.04 (95% CI, -0.10 to 0.01) vs -0.00 (95% CI, -0.06 to 0.05); P = NS	NR	NR by treatment group; narrative report of no AEs related to interventions
Murray et al, <sup>43</sup> 2013 (CLEAR)	n = 84	A: Lutein, 10 mg/d B: Placebo Follow-up: 1 y	Mean A: 72 B: 69	A: 56% B: 65%	NR	Visual acuity (logMAR) A: 0.10 B: 0.05	A vs B: Visual acuity, mean change from baseline: 0.01 vs -0.04; P < .05	NR	A vs B: Withdrawals due to AEs: 7.1% (3/42) vs 2.3% (1/42); RR, 3.00; 95% CI, 0.33-28

(continued)

Table 4. Treatment Studies of Antioxidant Vitamins, Minerals, and Other Supplements for Dry AMD Published Since the 2009 Review: Trials (Key Question 4)<sup>a</sup> (continued)

Source	Sample Size	Interventions and Follow-up	Age, y	Female	Race	Clinical Factors	Vision-Related Outcomes	Other Outcomes	Adverse Events
Souied et al, <sup>40</sup> 2013 (NAT2)	n = 300	A: Fish oil capsules (DHA, 280 mg + EPA, 90 mg + vitamin E, 2 mg) 3x/d B: Placebo (olive oil 602 mg) Follow-up: 3 y	Mean A: 74 B: 73	A: 69% B: 61%	NR	Mean visual acuity in study eye (logMAR): A: 0.14 B: 0.12 Drusen absent: A: 0.7% B: 0% Drusen <5: A: 0.7% B: 2% Drusen 5-20: A: 17% B: 22% Drusen >20: A: 81% B: 76% Current smoker: A: 7% B: 9% Former smoker: A: 14% B: 17% Nonsmoker: A: 79% B: 74%	A vs B: <sup>c</sup> Visual acuity, mean (SD) change from baseline logMAR: 0.155 (0.297) vs 0.116 (0.258); P = .31 Loss of visual acuity, participants with decrease >15 letters ETDRS: 17.8% (21/118) vs 14.3% (16/112); RR, 1.25; 95% CI, 0.69-2.26	A vs B: All-cause mortality: 2.2% (3/134) vs 4.7% (6/129); RR, 0.48; 95% CI, 0.12-1.88 Any AE: 93.3% (125/134) vs 89.1% (115/129); RR 1.05; 95% CI, 0.97-1.13 Any serious AE: 31.3% (42/134) vs 30.2% (39/129); RR, 1.04; 95% CI, 0.72-1.49 Serious ocular AE: 8.2% (11/134) vs 7.0% (9/129); RR, 1.18; 95% CI, 0.50-2.75 Cataract development, worsening, or need for cataract surgery: 50% (67/134) vs 62.5% (81/129); RR, 0.80; 95% CI, 0.64-0.99	A vs B: Any AE: 93.3% (125/134) vs 89.1% (115/129); RR 1.05; 95% CI, 0.97-1.13 Any serious AE: 31.3% (42/134) vs 30.2% (39/129); RR, 1.04 (95% CI, 0.72-1.49) Treatment-related AE (investigator-determined): 3.7% (5/134) vs 1.6% (2/129); RR, 2.41 (95% CI, 0.48-12) Serious ocular AE: 8.2% (11/134) vs 7.0% (9/129); RR, 1.18 (95% CI, 0.50-2.75) Ocular AE: 65.7% (88/134) vs 57.4% (74/129); RR, 1.14 (95% CI, 0.94-1.39) Cataract development, worsening or need for cataract surgery: 50% (67/134) vs 62.5% (81/129); RR, 0.80 (95% CI, 0.64-0.99) Serious nonocular AE: 23.1% (31/134) vs 23.2% (30/129); RR, 0.99 (95% CI, 0.64-1.54)

Abbreviations: AE, adverse event; aHR, adjusted hazard ratio; AMD, age-related macular degeneration; AREDS, Age-Related Eye Disease Study; aRR, adjusted risk ratio; BCVA, best-corrected visual acuity; CV, cardiovascular; DHA, docosahexaenoic acid; ETDRS, Early Treatment Diabetic Retinopathy Study; EPA, eicosapentaenoic acid; logMAR, logarithm of the minimum angle of resolution; NS, not significant; NR, not reported; OR, odds ratio; RR, relative risk.

<sup>a</sup> All 4 trials were rated good quality according to assessment detailed in eTable 3 in the Supplement.

<sup>b</sup> Focusing on AREDS categories 3 and 4 for vision-related outcomes, n = 2459; for categories 2, 3, and 4, n = 3476.

<sup>c</sup> Baseline characteristics for the original AREDS cohort.

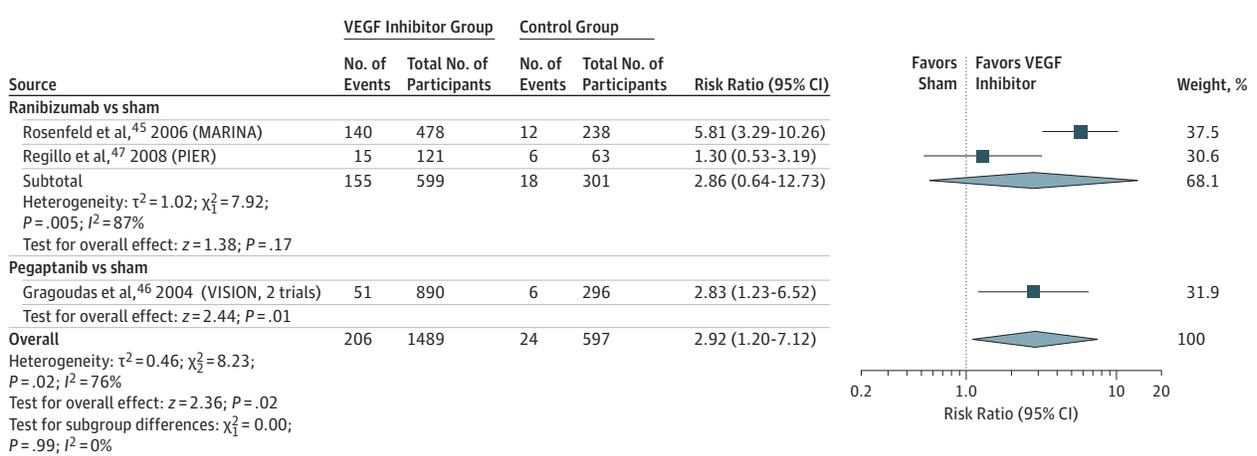
<sup>d</sup> Results for the subgroup of participants with AREDS category 3 or 4 AMD; results including AREDS category 2 AMD reported in the full review.<sup>12</sup>

<sup>e</sup> Results for participants with AREDS category 2, 3, or 4 AMD.

<sup>f</sup> Adjusted for age; sex; race; education; smoking status; body mass index; and presence of diabetes, angina, cancer, and hypertension.

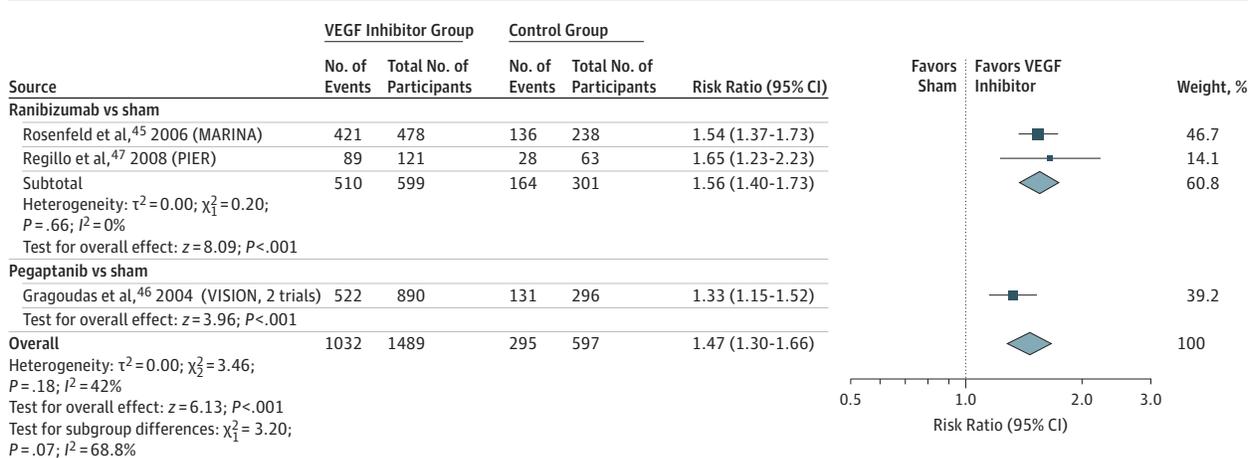
<sup>g</sup> Six-month, 1-year, and 2-year outcomes reported in the full review.<sup>12</sup>

Figure 3. Gain of 15 Letters or More of Visual Acuity With Use of VEGF Inhibitors at 1-Year Follow-up (Key Question 4)



The 2-year results for MARINA: risk ratio, 7.86 (95% CI, 4.08-15). VEGF indicates vascular endothelial growth factor.

Figure 4. Visual Acuity of 20/200 or Better With Use of VEGF Inhibitors at 1-Year Follow-up (Key Question 4)



The 2-year results for MARINA: risk ratio, 1.63 (95% CI, 1.44-1.86). VEGF indicates vascular endothelial growth factor.

and 1 study found that a questionnaire performed poorly as a screening test.<sup>26,27</sup> The 2009 USPSTF review found that no screening question is comparable in accuracy with tests of visual acuity for identifying impaired visual acuity<sup>19,20,23,24,56</sup> and that the Snellen test is inaccurate compared with a detailed eye examination for identifying visual conditions identified on a comprehensive ophthalmological examination. However, the clinical importance of asymptomatic conditions identified on an ophthalmologic examination is unclear and may vary depending on the condition. For example, treatments for cataracts may still be successful after the development of impaired visual acuity, whereas impaired visual acuity due to AMD could be irreversible. Although the Snellen test remains the most widely used tool to measure visual acuity in primary care settings, no clinically relevant reference standard exists to determine its diagnostic accuracy, in part because the Snellen test is often considered the standard for assessing visual acuity in clinical practice. There remains insufficient

evidence to assess the accuracy or utility of pinhole testing, the Amsler grid, visual acuity tests other than the Snellen test, physical examination, or fundoscopic examination performed in primary care settings.

Conclusions from the 2009 USPSTF review regarding the effectiveness of treatments vs no treatment for common causes of impaired visual acuity also remain unchanged. Based primarily on observational studies, a very high proportion of patients experience favorable vision-related outcomes after treatment for impaired visual acuity due to refractive error and cataracts.<sup>8</sup> Correction of refractive error and cataract removal are also associated with improvement in vision-related quality of life, although randomized trials and cohort studies have not shown clear effects on measures of general function, cognition, or depression.<sup>29-31,37,57</sup>

For dry AMD, evidence showing the effectiveness of antioxidant vitamins and minerals for slowing progression of disease or

Table 5. Summary of Evidence: Screening for Impaired Visual Acuity in Older Adults

Key Question Topic	Main Findings From 2009 USPSTF Review	No. of Studies (Participants) Identified for Update	Summary of Findings (Including Consistency and Precision)	Applicability	Limitations (Including Reporting Bias)	Overall Study Quality <sup>a</sup>
Key question 1: Benefits of screening	Three cluster RCTs found no difference between vision screening and usual care, no vision screening, or delayed screening on vision and other clinical outcomes. One RCT found vision screening by an optometrist in frail elderly persons associated with an increased risk of falls (rate ratio, 1.57; 95% CI, 1.20-2.05) and a trend toward increased risk of fractures (RR, 1.74; 95% CI, 0.97-3.11).	None	Unchanged from the 2009 review; no new studies. Evidence was consistent and imprecise.	Good (mainly primary care-applicable settings, as part of multicomponent screening intervention)	All studies had different types of comparators. Reporting bias was not detected.	Fair
Key question 2: Harms of screening	See Key Question 1 for evidence on falls.	None	Unchanged from the 2009 review; no new studies. Evidence was precise; unable to assess consistency (1 study).	Moderate (screening was done by an optometrist)	1 study only. Reporting bias was possible since most screening studies did not report harms.	Poor
Key question 3: Accuracy of screening	Four studies found screening questions are not accurate for identifying persons with vision impairment compared with Snellen chart. Four studies found visual acuity testing is not accurate for identifying presence of vision conditions compared with detailed ophthalmologic examination. One study found the Amsler grid is not accurate for identifying presence of vision conditions compared with detailed ophthalmologic examination. One very small (n = 50) study found nonophthalmologists are as accurate as ophthalmologists for identifying presence of cataracts. All studies were cross-sectional.	3 (n = 751)	Two new studies found that a computerized vision screening tool or a flip-chart version were not accurate compared with a detailed eye examination, and a third study found the MDS 2.0 Vision Patterns section associated with poor diagnostic accuracy compared with an eye chart; overall conclusions unchanged from the 2009 review. Evidence was consistent and precise.	Moderate (tests are practical for primary care but were sometimes performed by optometrists)	Sometimes unclear if the reference standards were interpreted independently of the target test, lack of predefined thresholds for positive results. Reporting bias was possible as some studies reported accuracy based on optimal criteria for a positive test.	Fair
Key question 4: Benefits of treatment						
Uncorrected refractive error	In 1 large population-based study, 60% of older adults with vision impairment can achieve visual acuity $\geq 20/40$ with refractive correction. Two RCTs found use of corrective lenses associated with improvements in vision-related function, but effects on overall function inconsistent. Numerous observational studies show that >85% of patients achieve visual acuity 20/40 or better following photorefractive surgery for myopia or hyperopia.	None	Unchanged from the 2009 review; no new studies. Evidence was consistent and precise.	Moderate	Mainly observational data and accumulated clinical experience. Reporting bias was not detected.	Fair

(continued)

Table 5. Summary of Evidence: Screening for Impaired Visual Acuity in Older Adults (continued)

Key Question Topic	Main Findings From 2009 USPSTF Review	No. of Studies (Participants) Identified for Update	Summary of Findings (Including Consistency and Precision)	Applicability	Limitations (Including Reporting Bias)	Overall Study Quality <sup>a</sup>
Key question 4: Benefits of treatment (continued)						
Cataract	Numerous observational studies found that >90% of patients achieve visual acuity $\geq 20/40$ after cataract extraction and intraocular lens implantation. Three observational studies found cataract surgery associated with improved vision-related function. One trial found immediate first-eye cataract surgery associated with a decreased rate of second (but not first) fall compared with delayed surgery, resulting in a lower overall rate of falls (rate ratio, 0.66; 95% CI, 0.40-0.96, $P = .03$ ), but a second trial found no effect of second-eye cataract surgery on falls.	2 prospective cohort studies (n = 346)	Two new studies reported improved visual acuity with surgery with no differences between groups on cognitive function or quality of life; overall conclusions unchanged from the 2009 review. Evidence was consistent for visual acuity and inconsistent for falls and precise.	Moderate	Mainly observational data. Reporting bias was not detected.	Fair
Dry AMD: vitamin and mineral supplements	A large, good-quality (n = 2556) randomized trial, AREDS reported results stratified according to the severity of AMD at baseline. Among subgroup of patients in whom treatment is currently recommended (AREDS categories 3 and 4), AREDS found an antioxidant and zinc combination effective for lower likelihood of AMD progression after 6 y of follow-up (adjusted OR, 0.66; 95% CI, 0.47-0.93), although the difference in the likelihood of $\geq 15$ letters of visual acuity loss was not statistically significant (adjusted OR, 0.75; 95% CI, 0.55-1.02). A systematic review of 9 trials (including AREDS) found insufficient evidence to determine efficacy of vitamins and minerals other than the AREDS combination.	1 systematic review (updated version of the previously included systematic review, with 4 new RCTs) 3 RCTs + 2 additional reports from the AREDS trial with 10-y follow-up (total n = 10 010)	Ten-year follow-up from AREDS is consistent with prior results, with antioxidant supplements alone (OR, 0.70; 95% CI, 0.56-0.88) or with added zinc (OR, 0.66; 95% CI, 0.53-0.83) associated with decreased risk of AMD progression and the combination associated with decreased risk of visual acuity loss (OR, 0.71; 95% CI, 0.57-0.88). Evidence on the effects of other vitamins and mineral treatments remains limited, with no clear effects on AMD progression or visual acuity; overall conclusions unchanged from the 2009 review. Evidence was consistent and precise.	Good (participants in AREDS and other studies generally had mild visual impairment at baseline)	Substantial heterogeneity in interventions assessed and outcomes reported. Reporting bias was not detected.	Good
Wet AMD: VEGF inhibitors	RR, 0.71, 95% CI, 0.61-0.84, 2 RCTs for pegaptanib (1 trial) and RR, 0.21, 95% CI, 0.16-0.27, 2 RCTs for ranibizumab (2 trials).	Additional publication from previously included trial	Unchanged from the 2009 review; no new studies. Evidence was consistent and precise.	Moderate	No new trials published since the prior review; study population in the 4 included trials was older (>75 y) with moderate to severe impaired visual acuity at baseline. Reporting bias was not detected.	Fair

(continued)

Table 5. Summary of Evidence: Screening for Impaired Visual Acuity in Older Adults (continued)

Key Question Topic	Main Findings From 2009 USPSTF Review	No. of Studies (Participants) Identified for Update	Summary of Findings (Including Consistency and Precision)	Applicability	Limitations (Including Reporting Bias)	Overall Study Quality <sup>a</sup>
Key question 5: Harms of treatment						
Uncorrected refractive error	One small prospective study found multifocal lenses associated with higher risk of falls in older adults compared with unifocal lenses (OR, 2.09; 95% CI, 1.06-4.92). Three studies found incidence of infectious keratitis ranges from 0.3 to 3.6 cases per 10 000 contact lens wearers; 1 study found incidence to be higher in persons >50 y. Corneal ectasia rates range from 0% to 0.87% in 5 studies of LASIK, keratitis rates range from 0% to 3.4% in 6 studies of LASIK and 4 studies of LASEK.	None	Unchanged from the 2009 review; no new studies. Evidence was consistent for contact lenses and refractive surgery (only 1 study for corrective lenses) and imprecise.	Moderate	Only 1 study on corrective lenses. Reporting bias was not detected.	Corrective lenses: poor Contact lenses, refractive surgery: fair
Cataract	Systematic reviews of numerous observational studies of cataract surgery found a pooled rate of posterior capsule opacification of 28% after 5 y and a pooled rate of 0.13% for endophthalmitis.	None	Unchanged from the 2009 review; no new studies. Evidence was consistent and precise.	Moderate	Mainly observational studies. Reporting bias was not detected.	Fair
Dry AMD: vitamin and mineral supplements	The large AREDS trial found zinc associated with significantly increased risk of hospitalization for genitourinary causes compared with nonuse of zinc (RR, 1.47; 95% CI, 1.19-1.80) and antioxidants associated with increased risk of yellow skin compared with nonuse of antioxidants (RR, 1.38; 95% CI, 1.09-1.75).	2 RCTs (n = 384)	Two new trials found no difference between supplement use vs placebo in risk of any AE (RR, 1.05; 95% CI, 0.97-1.13), serious AEs (RR, 1.05; 95% CI, 0.72-1.49), serious ocular AEs (RR, 1.18; 95% CI, 0.50-2.75), or withdrawals due to AEs (RR, 3.00; 95% CI, 0.33-28). No new evidence on AEs associated with zinc or antioxidants; overall conclusions unchanged from the 2009 review. Evidence was consistent and precise for any AEs but imprecise for other AEs.	Good (participants in both studies had relatively mild visual impairment at baseline)	Neither trial was designed to assess harms and sample sizes were relatively small (n = 94 and 300). Reporting bias was possible due to inconsistent reporting of harms.	Good
Wet AMD: VEGF inhibitors	More cases of endophthalmitis and uveitis compared with placebo, but small numbers of events. No increase in risk of systemic hypertension or arterial thromboembolic events.	None	Unchanged from the 2009 review; no new studies. Evidence was consistent and imprecise.	Moderate	Evidence limited to 4 older trials; few AEs reported. Reporting bias was possible due to inconsistent reporting of harms.	Fair

Abbreviations: AE, adverse event; AREDS, Age-Related Eye Disease Study; AMD, age-related macular degeneration; LASEK, laser assisted subepithelial keratomileusis; LASIK, laser assisted in situ keratomileusis; MDS, Minimum Data Set; OR, odds ratio; RCT, randomized clinical trial; RR, relative risk; SR, systematic review; USPSTF, US Preventive Services Task Force; VEGF, vascular endothelial growth factor.

<sup>a</sup> Overall study quality, summary of findings, applicability, and limitations are based on new evidence plus previously reviewed evidence.

improving visual acuity remains largely restricted to the large AREDS trial.<sup>38,41</sup> Extended (10-year) follow-up from AREDS is now available, showing continued benefits.<sup>39</sup> Antioxidants included in the AREDS formulation have been found to be associated with congestive heart failure (vitamin E<sup>58</sup>) and lung cancer in smokers (beta-carotene<sup>59,60</sup>) when prescribed for prevention of cancer or cardiovascular disease, although such harms were not observed in AREDS.

For wet AMD, evidence reviewed in the 2009 USPSTF review found intravitreal injection with VEGF inhibitors to be effective treatment options with a relatively low incidence of serious harms, although they may be associated with an increased risk of acute decline in visual acuity.<sup>61</sup> As detailed in the full review, photodynamic therapy and laser photocoagulation also appear to be associated with decreased risk of vision loss in patients with wet AMD but have been replaced as first-line therapy with VEGF inhibitors in most patients because of the risk of acute visual loss, need for retreatment (photodynamic therapy), and risk of permanent retinal damage (laser photocoagulation).<sup>12</sup>

Our evidence review has limitations. We excluded non-English language studies, which could introduce language bias. However, we identified no relevant non-English language studies, and some research found that exclusion of non-English language studies has little effect on conclusions of reviews of noncomplementary and alternative therapies.<sup>62</sup> In addition, trials of therapy for dry AMD evaluated heterogeneous vitamins, antioxidants, and other supplements and could not be pooled. There were also too few randomized trials to perform reliable assessments for publication bias.<sup>63</sup>

We identified important research gaps. Evidence indicates that screening can identify older patients with decreased visual acuity and there are effective treatments for common causes of impaired

visual acuity, yet screening was not associated with improved clinical outcomes. Well-designed studies in primary care settings are needed to identify optimal methods for vision screening and to develop effective strategies for linking older adults with impaired visual acuity to appropriate care, which would help maximize the potential benefits of screening. Studies are needed on the diagnostic accuracy and utility of funduscopic examination, pinhole testing, the Amsler grid, and non-Snellen visual acuity tests in primary care settings for supplementing or replacing the Snellen visual eye chart. Evidence on effectiveness of antioxidants and vitamins for dry AMD remains largely dependent on a single large trial<sup>38</sup> and would be strengthened by other, well-designed trials that are also designed to adequately evaluate potential harms associated with components of the supplements, such as congestive heart failure and lung cancer risk. More studies are needed to understand the potential association between correction of refractive errors and risk of falls<sup>16</sup> and, if an association is present, to identify methods for mitigating these risks. Research is also needed to understand the effectiveness of new therapies that are being investigated for their effectiveness in AMD, such as statins<sup>64</sup> and complement inhibitors (eg, protease inhibitors).<sup>65</sup>

## Conclusions

Screening can identify persons with impaired visual acuity, and effective treatments are available for common causes of impaired visual acuity, such as uncorrected refractive error, cataracts, and dry or wet AMD. However, direct evidence found no significant difference between vision screening in older adults in primary care settings vs no screening for improving visual acuity or other clinical outcomes.

### ARTICLE INFORMATION

**Author Contributions:** Dr Chou had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design:* Chou.

*Acquisition, analysis, or interpretation of data:* Chou, Dana, Bougatsos, Grusing, Blazina.

*Drafting of the manuscript:* Chou, Dana, Bougatsos, Grusing.

*Critical revision of the manuscript for important intellectual content:* Chou, Blazina.

*Statistical analysis:* Chou, Dana.

*Obtained funding:* Chou.

*Administrative, technical, or material support:* Dana, Bougatsos, Grusing, Blazina.

*Study supervision:* Chou, Bougatsos.

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provided project oversight; reviewed the report to ensure that the analysis met methodological standards, and distributed the draft for peer review. Otherwise, AHRQ had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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**Editorial Disclaimer:** This evidence report is presented as a document in support of the accompanying USPSTF Recommendation Statement. It did not undergo additional peer review after submission to *JAMA*.

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