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# Vision Change and Risk of Incident Depressive Symptoms in Middle-Aged and Older Adults: Evidence from Four International Longitudinal Cohorts

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## Abstract

# Background

Vision difficulties in midlife and later life may signal broader functional and psychosocial vulnerability. However, evidence remains limited on whether incident and persistent vision impairment are associated with later depressive symptoms across international aging cohorts. We examined this association in four longitudinal aging studies.

# Methods

We analyzed longitudinal data from the China Health and Retirement Longitudinal Study (CHARLS; China, W1–W3), the English Longitudinal Study of Ageing (ELSA; England, W4–W6), the Survey of Health, Ageing and Retirement in Europe (SHARE; Europe, W4–W6), and the Health and Retirement Study (HRS; United States, W10–W12). Reported vision across two consecutive waves was used to classify observed change patterns. Primary contrasts compared incident impairment and persistent impairment with persistently normal vision; improved vision was retained in model fitting when present but was not a primary contrast. Incident depressive symptoms were assessed at follow-up among participants below the depressive-symptom threshold at baseline. ELSA contributed a multiple-imputation main estimate (ELSA-MI) to address covariate missingness. Fully adjusted cohort-specific odds ratios (ORs) were pooled using random-effects meta-analysis.

# Results

The analytic sample comprised 47,250 participants (CHARLS: 7,247; ELSA-MI: 6,783; SHARE: 21,010; HRS: 12,210), yielding 6,513 incident depressive symptom cases. Incident impairment was associated with higher odds of incident depressive symptoms across cohorts: CHARLS (OR 1.56, 95% confidence interval [CI] 1.15–2.10), ELSA-MI (OR 1.70, 95% CI 1.25–2.31), SHARE (OR 1.24, 95% CI 1.11–1.39), and HRS (OR 1.56, 95% CI 1.27–1.92). The pooled OR was 1.45 (95% CI 1.23–1.71; $I^2$ = 56.5%). Persistent impairment showed a similar pattern (pooled OR 1.53, 95% CI 1.30–1.79; $I^2$ = 56.5%). Sensitivity analyses were directionally consistent.

# Conclusions

Across four longitudinal aging cohorts, incident and persistent reported vision impairment were associated with increased risk of subsequent incident depressive symptoms in middle-aged and older adults. Repeated vision assessment may provide a practical signal for identifying adults who warrant closer mental health monitoring in population-health, primary-care, and eye-care settings.

# Background

Vision impairment is a common and consequential health challenge in midlife and later life, with implications that extend beyond ophthalmic pathology. Visual difficulty can affect reading, mobility, social interaction, and confidence in daily activities, thereby linking sensory health with functional independence and psychosocial well-being. Among middle-aged and older adults, visual difficulty has been associated with activity limitation, diminished quality of life, and heightened vulnerability to depressive symptoms, anxiety, and social isolation (1–3). In this context, reported visual difficulty is not merely a marker of ocular status; it can also reflect the functional burden of vision problems as experienced in everyday life. This broader framing is relevant for aging research because vision problems may be noticed in routine surveys and clinical encounters before they lead to formal ophthalmic diagnosis or specialized care.

Population-based studies and systematic reviews have documented positive associations between visual impairment and depression or depressive symptoms (4–6). Longitudinal investigations have further suggested temporal relationships between vision loss and later depressive outcomes in older populations, with evidence from Australia, England, the United States, Korea, and China (7–12). These studies provide an important basis for considering vision problems as part of broader mental health risk assessment in aging populations. However, many prior analyses have relied on a single baseline vision assessment, a single national cohort, or cohort-specific measurement protocols, making it difficult to determine whether similar exposure-outcome patterns emerge across different aging studies. Evidence from multiple cohorts is particularly useful because associations observed in one setting may reflect local measurement choices, health-care access, social context, or cohort composition.

Vision status is not necessarily static over time. A single baseline measure may combine individuals with long-standing difficulty, newly developed difficulty, and potentially reversible or fluctuating symptoms, even though these patterns may carry different implications for psychological risk. More recent studies using change-pattern or cumulative-exposure frameworks suggest that new-onset, persistent, or recurrent sensory difficulties may be particularly informative for predicting depressive risk (13, 14). Distinguishing incident from persistent reported impairment may therefore help clarify whether depressive symptom risk is linked only to the presence of visual difficulty at one time point or also to the timing and continuity of perceived visual burden. This distinction may also be clinically meaningful: newly reported impairment may indicate a recent disruption in daily functioning, whereas persistent impairment may reflect sustained limitations and longer exposure to psychosocial stressors.

Several uncertainties remain. First, whether incident and persistent reported vision impairment demonstrate comparable associations with incident depressive symptoms across major aging cohorts from geographically diverse regions remains unclear. Second, reported vision and performance-based acuity are related but not interchangeable; reported difficulty may capture perceived functional burden and everyday stress that are particularly relevant to mental health outcomes (15–17). Third, depressive symptoms are assessed using different instruments across aging studies, making cross-cohort

inference most robust when emphasizing the direction and broad magnitude of associations rather than exact equivalence of symptom scales (18). These issues are especially relevant when evidence from several international aging cohorts is interpreted within a common longitudinal framework.

To address these gaps, we analyzed data from four international aging cohorts using a harmonized longitudinal framework. This design allowed the same exposure-change contrast to be examined across aging cohorts that differ in geography, survey setting, and depression measurement. We defined reported vision change from repeated vision items across two consecutive waves, focusing the primary analytical contrasts on incident impairment and persistent impairment versus persistently normal vision, and subsequently examined incident depressive symptoms. We hypothesized that both incident and persistent reported vision impairment would be associated with elevated risk of subsequent depressive symptoms across the four cohorts.

## Methods

# Study design and data sources

This study employed a harmonized four-cohort longitudinal design to examine the association between self-rated vision change and incident depressive symptoms among middle-aged and older adults. The analytic framework integrated data from the China Health and Retirement Longitudinal Study (CHARLS; Waves 1–3), the English Longitudinal Study of Ageing (ELSA; Waves 4–6), the Survey of Health, Ageing and Retirement in Europe (SHARE; Waves 4–6), and the Health and Retirement Study (HRS; Waves 10–12) (19–22). In CHARLS, ELSA, and SHARE, self-rated vision impairment was ascertained from two consecutive waves, with depressive symptoms evaluated at the subsequent wave. In HRS, vision data from Waves 10 and 11 and depressive symptom outcomes from Waves 11 and 12 were harmonized following the same analytic logic. Cohort-specific estimates were generated independently and subsequently pooled using random-effects meta-analysis. The participant selection flowchart is presented in Fig. 1.

Study population

Eligible participants were adults in the source aging cohorts with available self-rated vision data at two consecutive waves, depressive symptom scores below the prespecified threshold at baseline, follow-up depressive outcome data, and complete core demographic information. Because the four source cohorts use different age-eligibility frameworks, no additional common lower-age cutoff was imposed in the harmonized analysis; the resulting study population is therefore described as middle-aged and older adults. In CHARLS, Wave 2 served as the baseline risk assessment wave and Wave 3 as the outcome wave; in ELSA and SHARE, Wave 5 served as baseline and Wave 6 as outcome; in HRS, Wave 11 served as the baseline risk assessment wave and Wave 12 as the outcome wave. In ELSA, because depressive symptom items were derived from the psychosocial module, the main analysis was additionally restricted to participants who completed the relevant waves in person to minimize proxy-related

measurement concerns. The full supplementary table set provides harmonization, sample-flow, missingness, sensitivity-analysis, coverage, and follow-up details (Supplementary Tables S1-S6).

## Exposure definition

The exposure was defined as self-rated vision change between two consecutive waves. Wave-specific self-rated vision impairment was harmonized from the available vision items in each cohort. In CHARLS and SHARE, far and near vision items were used. In ELSA, far and reading vision items were used, with overall self-rated vision serving as an alternative indicator only when both primary items were missing. In HRS, Gateway HRS self-rated eyesight was classified as impaired when respondents reported fair, poor, or legally blind vision. Repeated assessments classified participants into four observed patterns where available: persistently normal vision, improved vision, incident impairment, and persistent impairment. The primary analytical contrasts compared incident self-rated vision impairment and persistent self-rated vision impairment with persistently normal vision as the reference category; improved vision was retained in model fitting when present but was not interpreted as a primary contrast of interest. This exposure was interpreted as perceived visual difficulty rather than standardized visual acuity, consistent with evidence that self-reported and performance-based vision measures are related but not interchangeable (15, 17). Detailed harmonization rules are provided in Supplementary Table S1.

## Outcome definition

The outcome was incident depressive symptoms at follow-up. CHARLS employed the 10-item Center for Epidemiologic Studies Depression Scale (CES-D10), with incident depressive symptoms defined as a score ≥ 10 at follow-up among participants with baseline scores < 10; abbreviated CES-D forms have been evaluated for depression screening in older adults (23). ELSA and HRS utilized the 8-item Center for Epidemiologic Studies Depression Scale (CES-D8), with incident depressive symptoms defined as a score ≥ 4 at follow-up among participants with baseline scores < 4. SHARE employed the European Depression Scale (EURO-D), with incident depressive symptoms defined as a score ≥ 4 at follow-up among participants with baseline scores < 4 (24). Given that depression instruments differed across cohorts, cross-cohort interpretation focused on the direction and relative magnitude of associations rather than exact equivalence of scale units, consistent with evidence that CES-D and EURO-D measures in older populations are related but not fully interchangeable (18).

## Covariates

The fully adjusted model incorporated age, sex, educational attainment, marital status, smoking status, alcohol consumption, body mass index (BMI), chronic disease burden, activities of daily living (ADL) and instrumental activities of daily living (IADL) functional limitation, socioeconomic status, and baseline subthreshold depressive symptom score. Chronic disease burden was operationalized as the count of harmonized chronic conditions available across cohorts. In HRS, physical activity was excluded from the

fully adjusted Model 2 due to absence of variation in the complete-case analytic sample. Harmonized covariate definitions are summarized in Supplementary Table S1.

# Statistical analysis

Within each cohort, binary logistic regression models were fitted with persistently normal vision as the reference category to estimate associations between incident and persistent self-rated vision impairment and incident depressive symptoms. Model 1 adjusted for core demographic variables, while Model 2 additionally incorporated lifestyle factors, chronic disease burden, functional status, socioeconomic status, and baseline depressive symptom score. Robust standard errors were applied within cohorts according to the available data structure. Adjusted absolute risks were estimated by average marginal standardization from the fully adjusted Model 2. To facilitate cross-cohort synthesis, fully adjusted cohort-specific log odds ratios (ORs) were pooled using DerSimonian-Laird random-effects meta-analysis (25), with heterogeneity quantified by $I^2$ (26), $tau^2$, and the 95% prediction interval (27). ELSA contributed a multiple-imputation pooled logistic OR to the main pooled analysis because covariate complete-case fitting would have excluded a substantial proportion of its main sample; this estimate is labeled ELSA-MI in the tables and figures. CHARLS, SHARE, and HRS retained complete-case Model 2 estimates as the primary estimates and were accompanied by covariate multiple-imputation sensitivity models using the corresponding Model 2 specification. Multiple-imputation analyses used 20 imputations with exposure, outcome, model covariates, and auxiliary variables in the imputation model and pooled estimates using Rubin-type rules, following established guidance for epidemiological and clinical research (28, 29). These analyses are reported in Supplementary Table S3. Supplementary Table S4 summarizes the coverage and cohort-specific availability of supporting analyses included in this study. Alternative effect-scale analyses employed modified Poisson models with robust standard errors (30), and E-values were calculated from the corresponding risk ratios to quantify the minimum unmeasured-confounding strength required to nullify the estimates (31) (Supplementary Table S5). Exploratory subgroup analyses stratified by age, sex, and chronic disease burden were fitted within each cohort using the Model 2 covariate set, with the stratifying variable omitted for sex- and chronic-burden strata. Analyses were conducted in Python 3.14.2 using pandas 3.0.0, statsmodels 0.14.6, scipy 1.17.0, scikit-learn 1.8.0, and matplotlib 3.10.8.

## Results

# Sample characteristics

Figure 1 displays the participant selection flow across the four cohorts. The fully adjusted analytic samples comprised 7,247 participants in CHARLS, 6,783 in ELSA-MI, 21,010 in SHARE, and 12,210 in HRS. The corresponding numbers of incident depressive symptom cases were 1,633, 474, 3,428, and 978, respectively. Together, these cohort-specific Model 2 estimates contributed 47,250 participants and 6,513 events to the random-effects meta-analysis. Baseline characteristics of the analytic samples are

summarized in Table 1; detailed attrition, missingness, and follow-up structure are provided in the supplementary material.

Table 1
Baseline characteristics of the four-cohort analytic samples in CHARLS, ELSA-MI, SHARE, and HRS.

| Section | Characteristic | CHARLS | ELSA-MI | SHARE | HRS |
|---|---|---|---|---|---|
| Sample | Analysis sample, n | 7247 | 6783 | 21010 | 12210 |
| Sample | Incident depressive symptoms, n (%) | 1633 (22.5%) | 474 (7.0%) | 3428 (16.3%) | 978 (8.0%) |
| Baseline characteristics | Age, years | 60.0 (9.2) | 66.2 (9.1) | 66.4 (9.3) | 66.9 (10.3) |
| Baseline characteristics | Male sex, n (%) | 3725 (51.4%) | 3088 (45.5%) | 9941 (47.3%) | 5212 (42.7%) |
| Education level | Lower education / ?11 years in HRS, n (%) | 6396 (88.3%) | 1750 (28.0%) | 7288 (34.7%) | 1954 (16.0%) |
| Education level | Middle education / 12–15 years in HRS, n (%) | 744 (10.3%) | 3224 (51.6%) | 8659 (41.2%) | 6875 (56.3%) |
| Education level | Higher education / ? 16 years in HRS, n (%) | 107 (1.5%) | 1273 (20.4%) | 5063 (24.1%) | 3381 (27.7%) |
| Baseline characteristics | Married or partnered, n (%) | 6225 (85.9%) | 4781 (70.5%) | 14341 (68.3%) | 8152 (66.8%) |
| Baseline characteristics | Current smoker, n (%) | 2375 (32.8%) | 764 (11.3%) | 3779 (18.0%) | 1472 (12.1%) |
| Baseline characteristics | Current drinker, n (%) | 3391 (46.8%) | 5740 (89.9%) | 15538 (74.0%) | 7107 (58.2%) |
| Baseline characteristics | BMI, kg/m^2 | 24.0 (3.8) | 28.2 (5.1) | 26.9 (4.6) | 28.5 (5.9) |
| Baseline characteristics | Chronic conditions, n | 0.9 (1.0) | 1.2 (1.1) | 1.4 (1.2) | 1.8 (1.3) |
| Baseline characteristics | Physical activity score | 3.2 (3.2) | 3.7 (1.0) | 2.5 (0.9) | Not included in HRS Model 2 |
| Baseline characteristics | ADL/IADL limitation score | 0.4 (1.0) | 0.5 (1.3) | 0.1 (0.5) | 0.1 (0.4) |
| Baseline characteristics | Socioeconomic status score (IHS-transformed) | 10.1 (5.5) | 12.3 (3.8) | 12.1 (3.3) | 10.8 (6.2) |

Note: ELSA-MI baseline descriptive statistics use observed baseline covariates in the MI analytic sample; inferential Model 2 estimates use the multiple-imputation pooled model. Note: HRS education is harmonized from education years and grouped as ≤ 11, 12–15, and ≥ 16 years; other cohorts use their harmonized three-level education variables. Note: HRS physical activity is not included in Model 2 because it showed no variation in the complete-case analytic sample.

| Section | Characteristic | CHARLS | ELSA-MI | SHARE | HRS |
|---|---|---|---|---|---|
| Baseline characteristics | Baseline depressive symptom score | 4.7 (2.7) | 0.8 (1.0) | 1.3 (1.1) | 0.7 (0.9) |

Note: ELSA-MI baseline descriptive statistics use observed baseline covariates in the MI analytic sample; inferential Model 2 estimates use the multiple-imputation pooled model. Note: HRS education is harmonized from education years and grouped as ≤ 11, 12–15, and ≥ 16 years; other cohorts use their harmonized three-level education variables. Note: HRS physical activity is not included in Model 2 because it showed no variation in the complete-case analytic sample.

## Main analysis

Table 2 presents the fully adjusted cohort-specific and pooled estimates. Incident reported vision impairment was associated with higher odds of incident depressive symptoms in CHARLS (odds ratio [OR] 1.56, 95% confidence interval [CI] 1.15–2.10), ELSA-MI (OR 1.70, 95% CI 1.25–2.31), SHARE (OR 1.24, 95% CI 1.11–1.39), and HRS (OR 1.56, 95% CI 1.27–1.92). Random-effects pooling yielded an OR of 1.45 (95% CI 1.23–1.71), with moderate heterogeneity ($I^2$ = 56.5%, $tau^2$ = 0.0153) and a 95% prediction interval of 1.08–1.95.

Table 2

Cohort-specific associations of incident and persistent self-rated vision impairment with incident depressive symptoms in CHARLS, ELSA-MI, SHARE, and HRS, including cohort-specific Model 2 odds ratios and pooled random-effects estimates.

| Exposure contrast | Cohort | Analysis sample, n | Incident cases, n | OR (95% CI) | *P* value | $I^2$, % | $tau^2$ | 95% prediction interval |
|---|---|---|---|---|---|---|---|---|
| New impairment vs persistent normal | CHARLS | 7247 | 1633 | 1.56 (1.15–2.10) | 0.004 | | | |
| New impairment vs persistent normal | ELSA-MI | 6783 | 474 | 1.70 (1.25–2.31) | < 0.001 | | | |
| New impairment vs persistent normal | SHARE | 21010 | 3428 | 1.24 (1.11–1.39) | < 0.001 | | | |
| New impairment vs persistent normal | HRS | 12210 | 978 | 1.56 (1.27–1.92) | < 0.001 | | | |
| New impairment vs persistent normal | Random-effects pooled | 47250 | 6513 | 1.45 (1.23–1.71) | < 0.001 | 56.5 | 0.0153 | 1.08–1.95 |
| Persistent impairment vs persistent normal | CHARLS | 7247 | 1633 | 1.71 (1.32–2.21) | < 0.001 | | | |
| Persistent impairment vs persistent normal | ELSA-MI | 6783 | 474 | 1.37 (0.92–2.04) | 0.119 | | | |
| Persistent impairment vs persistent normal | SHARE | 21010 | 3428 | 1.34 (1.19–1.51) | < 0.001 | | | |

| Exposure contrast | Cohort | Analysis sample, n | Incident cases, n | OR (95% CI) | *P* value | $I^2$, % | $tau^2$ | 95% prediction interval |
|---|---|---|---|---|---|---|---|---|
| Persistent impairment vs persistent normal | HRS | 12210 | 978 | 1.74 (1.44–2.10) | < 0.001 | | | |
| Persistent impairment vs persistent normal | Random-effects pooled | 47250 | 6513 | 1.53 (1.30–1.79) | < 0.001 | 56.5 | 0.0144 | 1.15–2.03 |

Persistent reported vision impairment showed a similar pattern. Cohort-specific ORs (95% CIs) were 1.71 (1.32–2.21) in CHARLS, 1.37 (0.92–2.04) in ELSA-MI, 1.34 (1.19–1.51) in SHARE, and 1.74 (1.44–2.10) in HRS. The corresponding pooled OR was 1.53 (95% CI 1.30–1.79), with $I^2$ = 56.5%, $tau^2$ = 0.0144, and a 95% prediction interval of 1.15–2.03. Across cohorts, the direction of association was consistent, and estimates for persistent impairment were generally larger than those for incident impairment. Single-contrast forest plots for incident and persistent impairment are provided in Supplementary Figures S1 and S2.

# Absolute risk summary

The adjusted absolute risk estimates followed the same pattern as the relative-effect results. In each cohort, adjusted probabilities of incident depressive symptoms were higher among participants with incident or persistent reported vision impairment than among those with persistently normal vision. Figure 2 presents the adjusted absolute risk gradient by cohort, including 95% CIs for all cohorts; ELSA-MI intervals were computed from the between-imputation distribution of adjusted probabilities. Absolute risk differences relative to persistently normal vision are provided in Supplementary Figure S3. The corresponding cohort-specific and random-effects relative estimates are displayed in Fig. 3.

# Subtype and sensitivity analyses

Supporting analyses are summarized in Table 3 and the supplementary material. Far- and near-vision subtype analyses were available for CHARLS, ELSA, and SHARE; HRS was not included in these subtype analyses because the Gateway HRS file provides a single self-rated eyesight item rather than separate far- and near-vision measures. The relevant estimates are presented in Table 3. Covariate multiple-imputation sensitivity analyses are reported in Supplementary Table S3, the analysis-coverage summary in Supplementary Table S4, modified Poisson and E-value analyses in Supplementary Table S5, and exploratory subgroup analyses by age, sex, and chronic disease burden in Supplementary Figure S4.

Table 3
Subtype analyses of far- and near-vision change in CHARLS, ELSA, and SHARE.

| Vision subtype contrast | CHARLS | ELSA | SHARE |
|---|---|---|---|
| Far vision: New impairment | 1.52 (1.23–1.89) | 1.30 (0.71–2.39) | 1.32 (1.15–1.51) |
| Far vision: Persistent impairment | 1.79 (1.49–2.14) | 1.77 (0.97–3.26) | 1.48 (1.25–1.75) |
| Near vision: New impairment | 1.36 (1.11–1.67) | 1.89 (1.19–3.01) | 1.19 (1.05–1.34) |
| Near vision: Persistent impairment | 1.32 (1.10–1.58) | 1.47 (0.78–2.74) | 1.31 (1.14–1.50) |
| HRS was not included in the far- and near-vision subtype analyses because the Gateway HRS file provides a single self-rated eyesight item rather than separate far- and near-vision items. | | | |

Across these supporting analyses, the findings remained in the same direction as the main Model 2 estimates. Covariate multiple-imputation estimates were directionally consistent across CHARLS, ELSA-MI, SHARE, and HRS (Supplementary Table S3). Modified Poisson models showed the same direction of association on a risk-ratio scale, with estimates exceeding the null for both incident and persistent impairment in all four cohorts (Supplementary Table S5). The exploratory subgroup results are presented as supportive evidence rather than primary pooled inference (Supplementary Figure S4).

# Discussion

The present study used a harmonized four-cohort longitudinal design to examine whether reported vision change was associated with subsequent incident depressive symptoms. Both incident and persistent reported vision impairment were associated with higher odds of incident depressive symptoms, and the direction of association was consistent across CHARLS, ELSA-MI, SHARE, and HRS. The pooled estimate was modestly larger for persistent impairment than for incident impairment, suggesting that both the onset and continuity of perceived vision problems are relevant to later mental health risk. Although cohort-specific estimates varied in magnitude and precision, the overall pattern supports repeated vision assessment as a practical way to identify middle-aged and older adults who may be at heightened risk of depressive symptoms.

These findings are consistent with systematic-review and population-based evidence showing that visual impairment and depression commonly co-occur (4–6). They also extend longitudinal studies reporting that vision loss, visual impairment, or self-reported sensory difficulty can precede depressive symptoms or related psychosocial outcomes in older adults (7–12). Evidence from the Three-City study and other national cohorts further supports long-term links between vision loss and later depression dimensions or depressive symptoms (32, 33). More recent work using change-pattern, cumulative-exposure, or visual-difficulty frameworks suggests that dynamic sensory burden may convey more prognostic information than a single baseline measure (13, 14, 34). The added value of the present study lies in testing whether the same exposure-change contrast identifies elevated incident depressive-symptom risk across four diverse aging studies, rather than providing another single-cohort confirmation.

Several pathways may explain the observed associations. Vision impairment can restrict mobility, reduce confidence in daily activities, and increase dependence, which may in turn elevate psychological distress; this interpretation is supported by evidence linking visual impairment to activity limitation, reduced quality of life, and subsequent functional deterioration (2, 3, 35). Reduced social participation and physical activity may also contribute, with longitudinal mediation evidence suggesting that these pathways partly account for the association between self-reported vision impairment and depressive symptoms (36). Persistent impairment may additionally reflect a longer period of functional strain or broader accumulation of frailty, loneliness, reduced social activity, chronic disease, and unmet care needs (37, 38). These pathways are not mutually exclusive, and the present observational design cannot determine whether reported vision impairment is causal, a marker of broader vulnerability, or both.

The moderate heterogeneity in the pooled estimates should be interpreted in light of measurement and contextual differences across cohorts. CHARLS, ELSA, SHARE, and HRS differed in survey setting, vision items, depressive symptom instruments, follow-up intervals, and event rates. Self-rated vision and performance-based acuity are related but not interchangeable, and self-rated difficulty may capture perceived functional burden more directly than acuity alone (15, 16). Harmonization research has also shown that estimated associations between vision and depression can vary depending on whether sensory impairment is defined by self-report or performance-based measures (17). Similarly, CES-D and EURO-D measures are correlated but not fully equivalent across older populations (18). For these reasons, the primary cross-cohort inference is the consistent direction of association under a common analytic framework, rather than exact equivalence of cohort-specific effect sizes.

The findings support considering reported vision impairment as a readily accessible signal of subsequent mental health risk in middle-aged and older adults. Because vision difficulty can be reported easily in surveys, public health surveillance, primary care, and eye-care settings, adults reporting new or persistent visual difficulty may benefit from closer monitoring for depressive symptoms and timely referral when appropriate. Evidence from eye-clinic, low-vision rehabilitation, and implementation settings suggests that depression burden is clinically relevant, screening can be acceptable, and practitioner training or embedded referral pathways can improve identification of depression risk (6, 39–41). Trials and reviews of stepped care and psychosocial interventions further suggest that mental health support for visually impaired older adults represents a plausible service target, although the optimal model remains uncertain (42, 43). These results do not imply that treating vision problems alone will prevent depression, but they identify a readily reportable risk signal that could prompt more integrated eye-health and mental-health awareness.

This study has several strengths. It drew on four established aging cohorts from different settings, allowing the same vision-change contrast to be examined in China, England, continental Europe, and the United States. The longitudinal design focused on incident depressive symptoms among participants below the baseline symptom threshold, and repeated vision assessment enabled incident impairment and persistent impairment to be distinguished from persistently normal vision. The analysis combined cohort-specific estimation with random-effects synthesis, presented both relative and adjusted absolute

risk summaries, and included sensitivity analyses addressing covariate missingness and alternative effect-scale specifications. This design provides a more informative assessment of later-life risk than a single baseline vision measure in one cohort alone.

# Limitations

Several limitations should be considered when interpreting the findings. Vision was assessed from reported survey items rather than standardized acuity testing or clinical eye-disease diagnoses, so the exposure is best interpreted as perceived visual difficulty. Depressive symptoms were measured with cohort-specific instruments, although each cohort used established symptom scales and the analysis emphasized the direction of association under a common framework. Residual confounding remains possible in this observational study, despite adjustment for demographic, socioeconomic, behavioral, health, functional, and baseline mood-related factors. Finally, the two-wave vision-change framework did not capture longer visual trajectories, treatment history, correction status, or the timing of eye-care interventions, and some supporting analyses were limited by cohort-specific measurement availability.

## Conclusions

Across four longitudinal aging cohorts, both incident and persistent reported vision impairment were associated with elevated risk of subsequent incident depressive symptoms in middle-aged and older adults. The association was directionally consistent across China, England, Europe, and the United States, supporting repeated vision assessment as a practical marker for identifying adults who may warrant closer mental health monitoring.

## Abbreviations

| | |
|---|---|
| ADL | Activities of daily living |
| BMI | Body mass index |
| CES-D | Center for Epidemiologic Studies Depression Scale |
| CES-D8 | Eight-item Center for Epidemiologic Studies Depression Scale |
| CES-D10 | Ten-item Center for Epidemiologic Studies Depression Scale |
| CHARLS | China Health and Retirement Longitudinal Study |
| CI | Confidence interval |
| ELSA | English Longitudinal Study of Ageing |
| ELSA-MI | ELSA multiple-imputation estimate |
| EURO-D | European Depression Scale |
| HRS | Health and Retirement Study |
| IADL | Instrumental activities of daily living |
| MI | Multiple imputation |
| OR | Odds ratio |
| RR | Risk ratio |
| SHARE | Survey of Health, Ageing and Retirement in Europe |

# Declarations

### Ethics approval and consent to participate

CHARLS, ELSA, SHARE, and HRS received approval from their respective institutional or national ethics review boards, and informed consent was obtained from participants according to each cohort's procedures. The present study used de-identified secondary data and involved no new participant recruitment or intervention.

### Consent for publication

Not applicable.

# Clinical trial number

Clinical trial number: not applicable.

# Competing interests

The authors declare no competing interests.

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# Author Contribution

KZ and SZ contributed equally to this work. KZ and YY conceived and designed the study. KZ and SZ performed the statistical analyses and interpreted the data. KZ and SZ drafted and revised the manuscript. WL and BL contributed to data verification, literature synthesis, and manuscript revision. DC and YY were responsible for supervision and writing review & editing. All authors read and approved the final manuscript.

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# Data Availability

The datasets analyzed in the current study are available from the parent cohort data repositories. CHARLS data are available from Peking University (http://charls.pku.edu.cn/en) after submitting a data use agreement to the CHARLS team. ELSA data are available through the English Longitudinal Study of Ageing data access procedures and the UK Data Service (https://www.elsa-project.ac.uk/data-and-documentation). SHARE data are available to registered users through the SHARE Research Data Center (https://share-eric.eu/data/data-access). HRS data are available from the Health and Retirement Study data portal after user registration (https://hrsdata.isr.umich.edu/). Analytic code and derived materials supporting the results are available from the corresponding author upon reasonable request, subject to the data use agreements of the original cohorts.

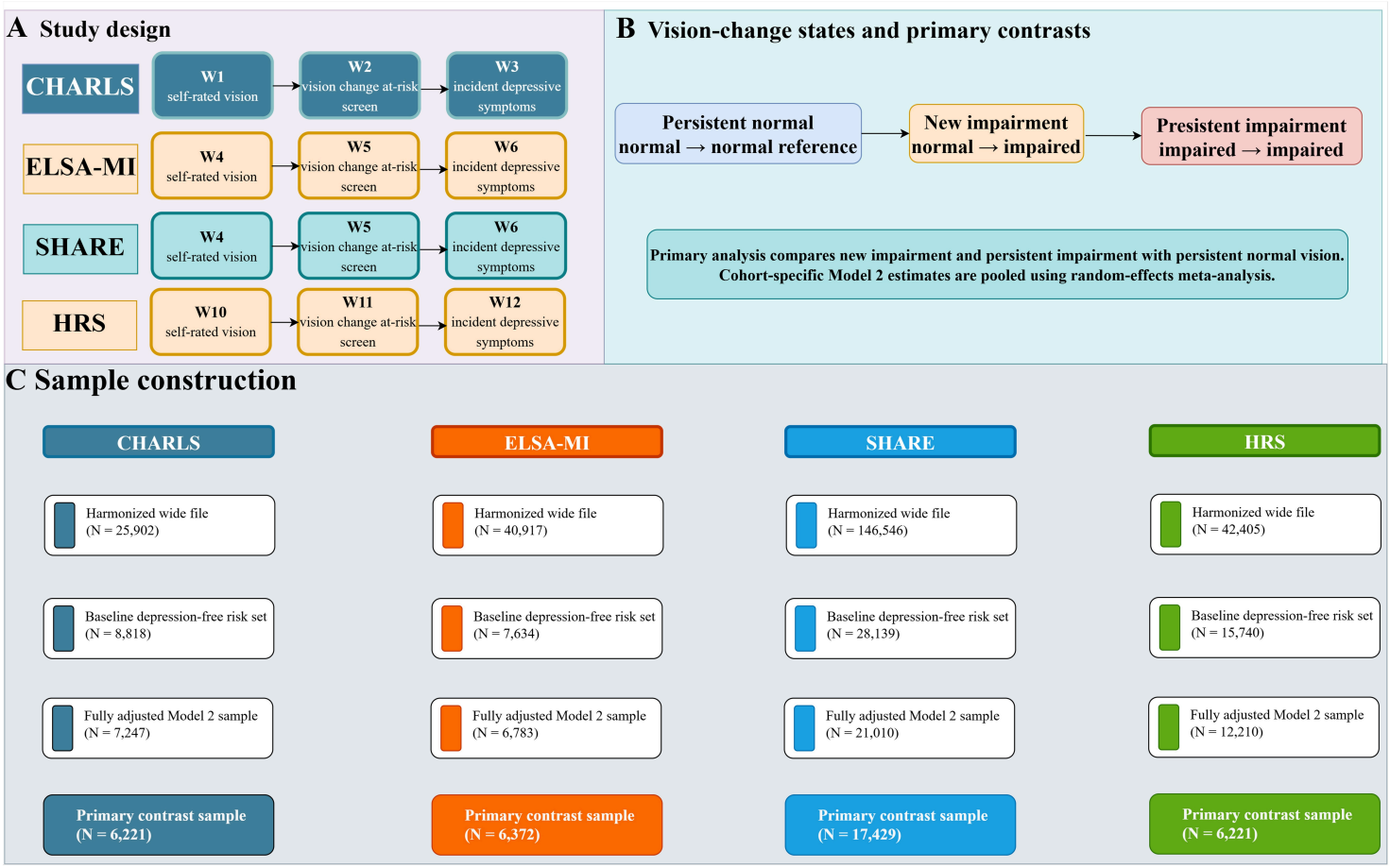
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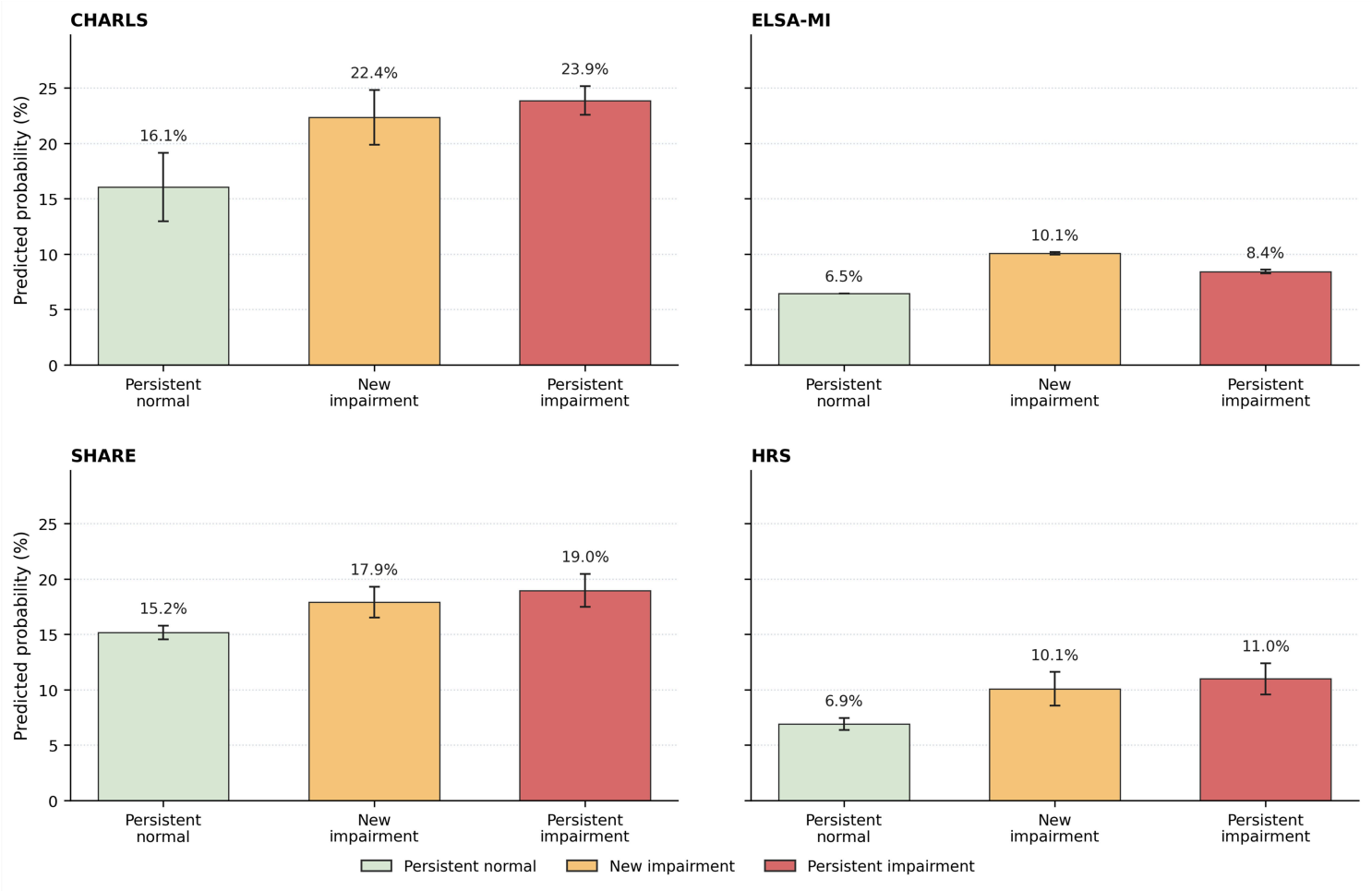
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# Figures




## Figure 1

Participant selection flow and harmonized analytic design across CHARLS, ELSA-MI, SHARE, and HRS.




## Figure 2

Fully adjusted predicted probabilities of incident depressive symptoms by self-rated vision change group across CHARLS, ELSA-MI, SHARE, and HRS. Predicted probabilities were estimated from fully adjusted Model 2; error bars indicate 95% confidence intervals.

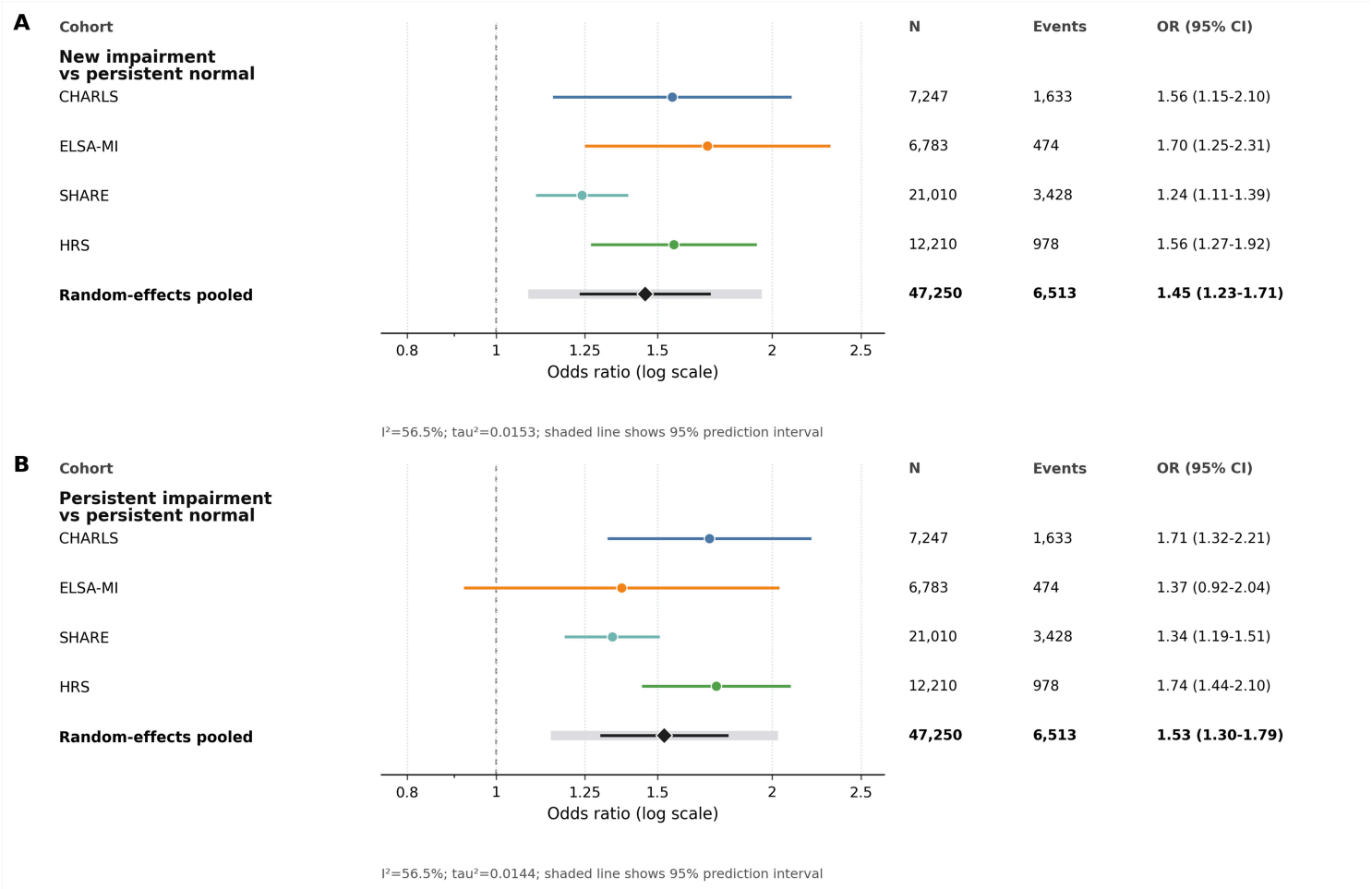



**Figure 3**

Cohort-specific and pooled forest plots for the associations of incident and persistent self-rated vision impairment with incident depressive symptoms across four cohorts.

# Supplementary Files

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- SupplementaryMaterial.docx