Systematic Review and Meta-Analysis of Eye-Tracking Technologies for Early Detection of Alzheimer's Disease and Mild Cognitive Impairment

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REVIEW TITLE AND BASIC DETAILS

Review title
Systematic Review and Meta-Analysis of Eye-Tracking Technologies for Early Detection of Alzheimer's Disease and Mild Cognitive Impairment

Condition or domain being studied
Alzheimer's Disease; Mild Cognitive Impairment; Cognitive function ; Eye Movement Disorders; Diagnostic Procedure

This review focuses on Alzheimer's disease and mild cognitive impairment (MCI) as neurodegenerative conditions. It evaluates the use of eye-tracking technology as a non-invasive diagnostic aid for early detection of cognitive decline. The review also examines the relevance of visual attention, pupil behavior, and gaze metrics in identifying early signs of cognitive dysfunction.

Rationale for the review
Alzheimer's Disease often develops silently over many years, with early signs like mild cognitive impairment going unnoticed. Current diagnostic methods, such as MRI and PET scans, are costly, invasive, and not widely accessible. This review aims to evaluate the effectiveness of eye-tracking technology as a non-invasive, affordable, and scalable diagnostic tool for early detection of Alzheimer's and MCI. It will synthesize recent findings to assess whether eye movement patterns can reliably indicate cognitive decline, providing a potential alternative to traditional diagnostics.

Review objectives
To assess the diagnostic accuracy of eye-tracking technologies in detecting early signs of cognitive decline, including mild cognitive impairment and Alzheimer's disease, compared to standard diagnostic tools. The review aims to determine which eye-tracking metrics are most predictive and how these tools can support non-invasive, early-stage screening.

Keywords
Eye-tracking; Alzheimer’s disease; Mild cognitive impairment; Digital diagnostics; Cognitive decline; Visual attention; Early detection

Country
Norway; Netherlands; United States of America

ELIGIBILITY CRITERIA

Population

Included

Inclusion: Adults aged 50 and above, diagnosed with mild cognitive impairment (MCI) or Alzheimer's disease, or cognitively healthy controls, as defined by standard clinical or cognitive criteria (e.g., MMSE, MoCA, DSM-5).

Exclusion: Participants with other neurological or psychiatric disorders (e.g., Parkinson's disease, major depression), uncorrected visual impairments, or studies not involving human participants.

Intervention(s) or exposure(s)

Included
Activity tracker; Attention Placebo Control; Diagnostic Procedure; Visual Acuity Testing; Intelligence Test

nclusion: Studies that assess eye-tracking-based diagnostic procedures, including fixation, saccade, and pupil metrics, in relation to detecting MCI or Alzheimer's Disease. Tools may include screen-based, 3D, or wearable eye-tracking systems.

Exclusion: Studies using non-eye-tracking digital methods alone (e.g., EEG, MRI), or studies not evaluating diagnostic potential.

Comparator(s) or control(s)

Included
Comparators must include a recognized diagnostic method for assessing cognitive function, such as MMSE, MoCA, MRI, PET, or clinician-administered diagnostic interviews. Studies that use these comparators to assess the presence or risk of MCI or Alzheimer's disease will be included.

Excluded
Studies using unrelated interventions as comparators (e.g., pharmacological treatments or lifestyle interventions) without a diagnostic component will be excluded. Also excluded are studies using only subjective caregiver reports without a clinical diagnostic method.

Study design
Both randomized and nonrandomized study types will be included.

Included
This review will include randomized controlled trials (RCTs), non-randomized studies, cohort studies, and case-control studies that evaluate eye-tracking metrics for the diagnosis or early detection of mild cognitive impairment or Alzheimer's disease. Diagnostic accuracy studies that include a comparator (e.g., MMSE, MoCA, MRI) will also be included.

Excluded
Editorials, reviews, case reports, letters, animal studies, and studies without original human data will be excluded.

Context
Studies conducted in clinical, research, or community-based settings involving cognitive assessments through eye-tracking will be included. Both inpatient and outpatient environments will be considered. No restrictions will be applied based on country, income level, or healthcare setting, as long as participants are human and eye-tracking is used as a diagnostic tool for MCI or Alzheimer's Disease.

SIMILAR REVIEWS

Check for similar records already in PROSPERO
PROSPERO identified a number of existing PROSPERO records that were similar to this one (last check made on 2 April 2025). These are shown below along with the reasons given by that the review team for the reviews being different and/or proceeding.

- Prediction of Alzheimer’s Disease and Mild Cognitive Impairment (MCI) Using Cognitive Tests (2000–2025): A Systematic Review Protocol [published 22 January 2025] [CRD42025640892]. The review was judged **not to be similar**

- Eye Tracking in Ophthalmology: From Diagnosis to Rehabilitation [published 1 March 2024] [CRD42024514365]. The review was judged **not to be similar**
- Eye-tracking tasks using naturalistic stimuli to detect oculomotor anomalies in Alzheimer's disease e Mild Cognitive Impairment patients: a systematic review. [published 20 November 2023] [CRD42023480688]. The review was judged **not to be similar**

TIMELINE OF THE REVIEW

Date of first submission to PROSPERO
This record has not been submitted.

Review timeline
No start date given. No end date given.

Date of registration in PROSPERO
This record has not been published.

AVAILABILITY OF FULL PROTOCOL

Availability of full protocol
A full protocol has not been written.

SEARCHING AND SCREENING

Search for unpublished studies
Only published studies will be sought.

Main bibliographic databases that will be searched
The main database to be searched is *PubMed*.

Search language restrictions
The review will only include studies published in English.

Search date restrictions
There are no search date restrictions.

Other methods of identifying studies
Other studies will be identified by: *contacting authors or experts*, *looking through all the articles that cite the papers included in the review ("snowballing")* and *reference list checking*.

Link to search strategy
A full search strategy is not available.

Selection process
Studies will be screened independently by at least two people (or person/machine combination) with a process to resolve differences.

Other relevant information about searching and screening
Search results from PubMed were imported directly into Zotero using RSS feeds to automatically track new publications within the defined search window. Screening was conducted using titles and abstracts, followed by full-text review where necessary. Duplicates were removed manually. Screening decisions were documented in Zotero with colored tags and notes, and disagreements between reviewers were resolved through discussion.

DATA COLLECTION PROCESS

Data extraction from published articles and reports
Data will be extracted independently by at least two people (or person/machine combination) with a process to resolve differences.

Authors will be asked to provide any required data not available in published reports.

Study risk of bias or quality assessment
Risk of bias/study quality will not be assessed.

Reporting bias assessment
Risk of bias due to missing results will be assessed by examining publication bias and selective outcome reporting. Where ≥10 studies are included in a synthesis, funnel plots will be used to visually assess asymmetry. Additionally, statistical tests such as Egger's regression may be used to quantify small-study effects.

Certainty assessment
The certainty of evidence for each primary outcome will be assessed using the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) approach. This method considers study limitations, inconsistency, indirectness, imprecision, and publication bias. The certainty will be categorized as high, moderate, low, or very low. Two reviewers will perform assessments independently, with disagreements resolved by discussion.

OUTCOMES TO BE ANALYSED

Main outcomes
The primary outcome is the diagnostic accuracy of eye-tracking technology in detecting mild cognitive impairment (MCI) and Alzheimer's disease. Acceptable measurements include fixation duration, saccade latency, error rates, and pupil dilation, collected during task-based assessments. Reported outcomes will include sensitivity, specificity, area under the receiver operating characteristic curve (AUC), and overall accuracy. Time points may vary depending on study design, but baseline or initial diagnostic results will be prioritized. Effect sizes will be synthesized using pooled estimates with 95% confidence intervals.

Additional outcomes
Additional outcomes will include usability and feasibility metrics of eye-tracking tools (e.g., time to administer, user comfort, device calibration success rate), as well as correlations with traditional cognitive assessments such as MMSE and MoCA scores. Studies reporting cost-effectiveness, patient acceptability, or integration with AI diagnostic models will also be included where available. Outcomes will be extracted as reported, and effect sizes (e.g., correlation coefficients, mean differences) will be synthesized where possible.

PLANNED DATA SYNTHESIS

Strategy for data synthesis
Data will be synthesized using meta-analytic methods where sufficient homogeneity exists. Diagnostic accuracy measures, including sensitivity, specificity, and AUC (area under the curve), will be pooled using a bivariate random-effects model. Heterogeneity across studies will be assessed using the I^2 statistic and visual inspection of forest plots. Subgroup analyses will be performed based on task type, participant group (MCI vs AD), and eye-tracking system used. Where meta-analysis is not feasible due to data limitations, a narrative synthesis will be provided.

CURRENT REVIEW STAGE

Stage of the review at this submission

Review stage	Started	Completed
Pilot work	✓	✓
Formal searching/study identification	✓	✓
Screening search results against inclusion criteria	✓	
Data extraction or receipt of IPD		
Risk of bias/quality assessment		
Data synthesis		

Review status
The review is currently planned or ongoing.

Publication of review results
Results of the review will be published.

REVIEW AFFILIATION, FUNDING AND PEER REVIEW

Review team members
Ms zohreh Mehravipour (review guarantor and contact) Voodoolily Publishing House. Norway.

No conflict of interest declared.

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No conflict of interest declared.

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Review affiliation
O'Vista Cognitive Health Research; Voodoo Lily Research Group

Funding source
Review has no specific/external funding but is supported by guarantor/review team (non-commercial) institutions.

Additional information about funding
Supported internally by the Voodoo Lily Research Group through the O'Vista initiative.

Peer review
There has been no peer review of this planned review.

ADDITIONAL INFORMATION

Additional information
This review is part of the O'Vista Cognitive Health Initiative, led by the Voodoo Lily Research Group, exploring the role of eye-tracking and AI in early detection of Alzheimer's and cognitive impairment. The findings will support the development of a non-invasive digital diagnostic tool aimed at both elderly individuals and students with learning difficulties.

Review conflict of interest
Declared individual interests are recorded under team member details.. No additional interests are recorded for this review.

Medical Subject Headings

Alzheimer Disease; Cognitive Dysfunction; Electroencephalography; Eye-Tracking Technology; Humans; Neurodegenerative Diseases; Pupil; Saccades; Wearable Electronic Devices

PROSPERO version history

No preview available

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