Accuracy and reliability of self-administered visual acuity tests: Systematic review of pragmatic trials

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Background

- Visual acuity (VA) is one of the foundational elements of clinical assessment in ophthalmology.
- Outside specialist settings, VA testing is frequently poorly executed due to lack of equipment, specialist training, and time.
- Remote self-administered VA tests could allow patients and non-specialists to assess vision without input from a eye health professional.
- Validation in pragmatic (real-world) trials is necessary to demonstrate the effectiveness (rather than the efficacy) of tests before deployment is considered.
- Specifically, determining accuracy and reliability is required, permitting comparison with conventional clinical tests to judge if the remote VA tests are appropriate to use.

Methods

- A systematic review was undertaken in accordance with a preregistered protocol.
- The Cochrane Library, Embase, MEDLINE, and Scopus were searched.
- Screening was conducted according to the following criteria: (1) English language; (2) primary research article; (3) visual acuity test conducted out of eye clinic; (4) no clinical administration of remote test; (5) accuracy or reliability of remote test analysed.
- Quality assessment was conducted with QUADAS-2.
- All available accuracy and reliability data were extracted for analysis.

Results

- Of 1227 identified reports, 10 studies were ultimately included (Figure 1).
- Most studies were prospective cross-sectional surveys, with just one retrospective case-control study.
- Reported participant age ranged from 3 to 95 years old; spanning most of the range of ages of patients.
- All studies appraised accuracy by comparing remote measurements to assessment in clinic. The gold-standard ERDRS chart was only used as the reference test in one study.

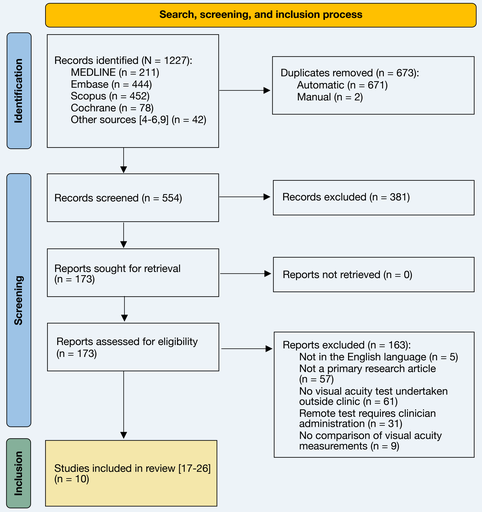


Figure 1 | *Flow-cart detailing the search, screening, and inclusion process for this systematic review. 10 studies were included in the final analysis.*

Citation	Index test	Reference test	Bias (LLOA, ULOA)
Adyanthaya and B, 2022	iSight Professional	Snellen chart	0.06 (0.04, 0.10)
	Peek Acuity	Snellen chart	0.07 (0.04, 0.10)
Almagati and Kran, 2021	FrACT	Clinic assessment	−0.09
Bellsmith et al, 2022	University of Arizona/Banner Eye Health Chart	Snellen chart	−0.07 (−0.39, 0.25)
	Verana Vision Test	Snellen chart	−0.12 (−0.50, 0.26)
	Farsight.care	Snellen chart	−0.13 (−0.53, 0.27)
Chen et al, 2022	Acustat	Snellen chart	(−0.2278, 0.2235)
Chen et al, 2021	Letter Distance Chart PDF document	Snellen chart	−0.02 (−0.31, 0.26)
	Letter Distance Chart PDF document	Snellen chart	−0.02 (−0.31, 0.27)
Painter et al, 2021	iSight Professional or Peek Acuity	Clinic assessment	−0.14 (−0.88, 0.60)
Pathipati et al, 2016	Paxos Checkup	Rosenbaum near card	−0.06
Siktberg et al, 2021	ETDRS vision chart PDF document	ETDRS chart	0.078
Thirunavukarasu et al, 2022	DigiVis	Clinic assessment	−0.001 (−0.175, 0.173)

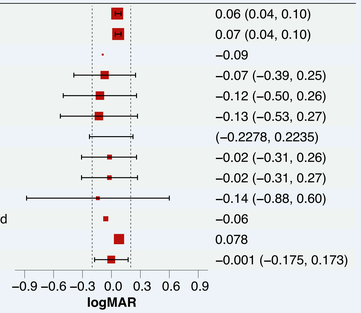


Figure 2 | *Forest plot depicting the accuracy of remote visual acuity tests when compared to gold-standard clinical (reference) tests. DigiVis was the only test with consistent limits of agreement within those reported for repeat clinical testing. LLOA = lower 95% limit of agreement; ULOA = upper 95% limit of agreement; PDF = portable document format; ETDRS = Early Treatment of Diabetic Retinopathy Study; logMAR = logarithm of the minimum angle of resolution.*

- Three trials—of DigiVis, iSight Professional, and Peek Acuity—from two studies suggested that accuracy of the remote VA tests is comparable to clinical assessment (Figure 2).
- One trial of a custom e-device did not report any statistical analysis of individual data.
- All other trials exhibited inferior accuracy, including conflicting results from a pooled study of iSight Professional and Peek Acuity (Figure 2).
- Bias tended to be low across all the trialled tests, indicating that there was no systematic difference in self-administered VA tests to clinical tests.
- The three most accurate tests required access to digital devices.
- Two studies evaluated test-retest agreement—one trial provided evidence that DigiVis is as reliable as clinical assessment.
- 6 of 10 studies reported conflicts of interest, suggesting that many studies were undertaken by research teams associated with the application being validated.
- However, risk of bias (quantified with QUADAS-2) was generally low. One study was at high risk of bias and two studies exhibited concerning features of bias; all studies were applicable.
- Reporting was inconsistent and often incomplete, particularly with regards to describing methods and conducting statistical analysis.

Conclusions

- Remote self-administered VA tests appear promising, with some tests exhibiting comparable accuracy to clinical VA tests.
- This review was limited by three factors:
  1. Inconsistent and incomplete statistical analysis.
  2. Unclear descriptions of study settings, particularly in how remote VA tests were administered.
  3. Lack of use of ETDRS or Bailey-Lovie charts as the reference gold-standard.
- There is a paucity of evidence for the reliability of evidence, and currently only DigiVis has validation data confirming comparable accuracy and test-retest reliability to clinical tests.
- Durther pragmatic trials are indicated to justify deployment in carefully defined contexts to facilitate patient or non-specialist led assessment.
- Remote VA tests could augment tele-ophthalmology, non-specialist eye assessment, pre-consultation triage, and autonomous long-term monitoring of vision.

Peer-Reviewed Report

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