Colour vision screening: a critical appraisal of the literature
New Zealand Health Technology Assessment

Authors' objectives
To provide an evidence-based review evaluating colour vision screening through the use of recognised criteria.

Searching
The sources searched included: Index Medicus/MEDLINE, HealthSTAR, Current Contents (combined files), CINAHL, the Cochrane Library, Best Evidence CD-ROM, EMBASE, ERIC, PsycLIT, Sociofile, Social Science Index, Science Citation index, Social Citation Index, DARE, NHS EED TRIP - Gwent Health Authority, publications and current projects of INAHTA, New Zealand Health Information Statistics, and reference lists of documents obtained during the course of the project. A handsearch of Index Medicus took place under the headings "color blindness" and "color perception" for the years 1924-1934 and 1955-1960 (these years were selected due to an apparent interest in the prevalence of colour vision defects during these years. The other sections of the literature search were restricted to the previous 10 years (until late June and early July 1998). The search strategies used for the MEDLINE/HealthSTAR and EMBASE references were provided in the appendix. The HealthSTAR search was limited to non-MEDLINE references. The other databases were searched using the thesaurus heading "color vision" where available, or if there was no controlled vocabulary, the keywords "vision/color vision".

Articles in languages other than English, French and German were excluded.

Study selection
Study designs of evaluations included in the review
Meta-analyses, randomised controlled trials (RCTs), cohort studies, case-control studies, before and after studies and descriptive studies were eligible for inclusion in the review. Economic analyses were also considered.

The following criteria were used to exclude studies from appraisal: participation rate <50%, sample size < 25, updated results published, papers for debate or editorials, abstract only.

Specific interventions included in the review
Studies examining the validity of colour vision screening tests or colour vision screening programmes were eligible for inclusion in the review.

Specific screening tests used in included studies were: Pease-Allen colour test (PACT), Ishihara, Ishihara unlettered, Ishihara (pathway), American Optical Hardy-Rand-Rittler (AO-HRR), Panel D-15, F-2, Kojima-Matsubara test plates, Anomaloscopy, the Anomoloscope Plate Test (APT-5), Velhagen Pflugertrident Test, Hahn pseudoisochromatic test, standard pseudoisochromatic test, pseudoisochromatic plates (new design), Farnsworth-Munsell D-15, Farnsworth Lantern, Farnsworth F-2, Guys, Matsubara, Ishihara and AO-HRR plates versus slides, Panel D-15 desaturated, F-M (10) 100-hue, F-M 100-hue test versus colour screening inventory, and the Lanthony Tritan Album.

In one study that examined options for the treatment of colour vision deficiencies, long wavelength pass filters were used as a treatment.

Reference standard test against which the new test was compared
No inclusion criteria relating to any reference standard test were specified. Reference standard tests used in included studies, where specified, were anomaloscopy or AO-HRR.

Participants included in the review
Participant inclusion criteria were not provided. Studies were excluded if there were significant differences in the baseline characteristics of their case and control groups, or if there was a lack of reported demographic details of the study participants.
For studies investigating the sensitivity and specificity of colour vision tests, the age of participants ranged from 4 to 63 years. The samples included: "the adult population", colour normal adults, adults with red-green colour deficiency, children, students, and vision impaired participants (who had been referred to an optometry colour vision clinic).

The mean age of participants involved in the sensitivity of colour vision screening tests ranged from 19.9 to 28. Participants included: red-green colour deficient males, people with congenital colour vision impairment, people with impaired colour vision (diagnosed by anomaloscopy), and volunteers.

In studies evaluating the validity of colour vision screening tests with "other" outcome measures, participants were age 3-74. Participants included patients with congenital red-green colour blindness, patients with optic neuritis, and controls with no colour impairment.

The single study investigating the repeatability of the Ishihara test involved colour vision impaired participants between 17 and 35 years of age.

In studies evaluating how children perform on colour vision testing, children were aged 2 to 13 years.

In four studies evaluating screening programmes that stated participant age, it ranged from 8 to 16 years.

Outcomes assessed in the review
No inclusion criteria were specified with respect to outcome measures.

The following outcomes were assessed in the review: sensitivity, specificity, repeatability, acceptability, positive predictive value and negative predictive value.

How were decisions on the relevance of primary studies made?
A single reviewer applied the inclusion criteria.

Assessment of study quality
Articles were formally appraised using the schedule developed by the Group Health Cooperative of Puget Sound (see Other Publications of Related Interest) and adapted by the New Zealand Guidelines Group of the National Health Committee (New Zealand Guidelines Group, 1977; see Other Publications of Related Interest no.1). Study appraisals were presented in a narrative form.

In addition, grades of evidence were assigned using the U.S. Preventive Services Task Force protocol (see Other Publications of Related Interest, no.2).

The authors do not state how the papers were assessed for validity, or how many of the reviewers performed the validity assessment.

Data extraction
A single reviewer extracted data from the studies.

Methods of synthesis
How were the studies combined?
Studies were combined as a narrative.

How were differences between studies investigated?
Tests for heterogeneity were not performed. The limitations of the individual primary studies were discussed in the text.

Results of the review
Sixty-one studies were included in the review, but only the 27 studies relating to the effectiveness of health
interventions are reported here. One study (comprising 29 participants) investigated options that exist for the treatment of colour vision deficiencies. Seventeen of the 27 included studies evaluated the validity of various colour vision screening tests. Of these, seven studies (4194 participants) examined the sensitivity and specificity of specific colour vision tests in the same study, five further studies (comprising 1556 participants) provided information on sensitivity alone, one study (comprising 102 participants) evaluated the test-retest reliability of the Ishihara, and four studies (comprising 1449 participants) evaluated "other" methods of assessing the validity of colour vision screening tests used. Five additional studies (comprising at least 2391 participants - this information was not available in 2 studies) investigated how young children performed on colour vision testing.

Four of the included studies, comprising at least 1516 participants (numbers not reported in one study), evaluated aspects of colour vision screening programmes.

In one study that investigated the options for treatment of impaired colour vision, long wavelength pass filters were used as treatment. Overall effectiveness was rated as "not very effective" in 44% and only 17% were interested in purchasing the lenses after a one week trial.

There were three studies that measured the sensitivity and specificity of more than one colour screening test against anomaloscopy. Ishihara's test was used in all three of those studies. In each case, there was no evidence that Ishihara's test was less valid than any other screening test. One of the three studies surveyed a much younger age group (4-11 years) and the sensitivity and specificity for all the screening tests was lower in that study than the other two.

The sensitivity of Ishihara's test (after excluding the study that included a pre-school population) ranged from between 94% and 98% (mean 96%) and the specificity ranged from between 95% and 100% (mean 98.5%). In one study that evaluated the repeatability of Ishihara's test, good retest reliability was found.

Consideration was given to the best age at which to perform colour vision screening. The authors suggest that ideally, screening should be performed when it will make a difference to the three potential sequelae of impaired colour vision: educational and occupational difficulties and increased problems with driving. From the educational viewpoint, a test preceding school entrance would be useful. However, the screening tests appeared to have lower validity in these younger age groups. All screening tests evaluated appeared to have inferior performance in pre-school children, although this was not tested in a direct comparison.

Four studies were found which investigated the effectiveness of colour vision screening programmes, but these evaluated aspects of screening programmes rather than the whole programme. Three studies used a cross-sectional design and the other was a non-systematic review. Therefore it was concluded that it was not possible to evaluate the effectiveness of a colour vision screening programme on the basis of current research.

**Cost information**
The cost-effectiveness of colour vision screening could not be estimated due to lack of research in this area.

**Authors' conclusions**
There were no adequate treatment options for the correction of impaired colour vision on current evidence.

There was insufficient evidence:

1. For the use of colour vision screening as a method of first detection of an adverse health outcome other than impaired colour vision.

2. To recommend a change in the colour vision screening test currently in use within New Zealand (Ishihara's pseudoisochromatic test) on the basis of its validity.

3. To recommend a change in the age at which colour vision screening should occur in New Zealand.

Four studies evaluated aspects of colour vision screening programmes. These studies were insufficiently rigorous in
design to allow an estimation of the effectiveness of the programmes surveyed.

**CRD commentary**
A clear review question was provided. Sufficient details of the primary studies were given, and studies were summarised appropriately.

No attempt was made to locate grey literature, and thus publication bias cannot be ruled out (highlighted by the authors). In addition, experts in the field could have been contacted for further information. Participant and intervention inclusion criteria were not stated. Studies were formally appraised, although a scoring system was not used.

The conclusions follow from the results. The conclusions focus mainly on the Ishihara test, which is currently used for screening purposes in New Zealand.

**Implications of the review for practice and research**
Research: The authors suggest that cost-effectiveness information is needed to compare the costs of the various screening tests against sensitivity and specificity criteria. In addition, they suggest that the cost-effectiveness of colour vision screening is an area requiring further research.

The authors suggest that future research should attempt to evaluate the effectiveness of a colour vision screening programme, using a randomised controlled trial. In addition, they suggest that future research should focus on directly comparing the performance of Ishihara's test in various age groups.

**Bibliographic details**

**Original Paper URL**

**Other publications of related interest**


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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.