The Royal Australian and New Zealand College of Ophthalmologists

RANZCO Position Statement: Pre-school / Early School-based Children's Vision Screening Programs

Approved by: Board **Version:** Current **Department**: Advocacy	**Next review date:** May 2026 **Approval date**: 1 May 2023 **Policy inventory number:** 221.2023.05 01

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We acknowledge the Aboriginal and Torres Strait Islander Peoples, the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and community. We pay our respects to them and their cultures; and to their Elders past, present and emerging.
In recognition that we are a bi-national College, we also acknowledge the Rangatiratanga of Māori as Tangata Whenua and Treaty of Waitangi partners in Aotearoa New Zealand.

1. Purpose and scope

This position statement was developed by the Royal Australian and New Zealand College of Ophthalmologists (RANZCO) to provide recommendations on the usefulness of pre-school / early school-based children's vision screening programs. It does not purport to be a systematic review but has taken advantage of systematic reviews to which reference is made.

2. Background- why screen?

Throughout 2021-2022, RANZCO participated in extensive stakeholder collaboration for the development of a minimum national standard for children's vision screening. The Vision2020 Australia Children's Vision Screening Working Group included representation from peak organisations across the eye health sector including orthoptics and optometry as well National Aboriginal Community Controlled Health Organisation (NACCHO) and Brien Holden Vision International (BVHI). Outputs from this process have included a Children's Vision Screening National Framework and Advocacy Strategy including steps toward implementation across jurisdictions. Based on evidence in the international literature, this position statement highlights the efficacy of a Children's Vision Screening program at pre-school early school age.

Vision is a developed sense which requires straight eyes with clear images in each eye during early childhood for best visual potential to be reached. Visual development is rapid, particularly in the first few months of life and is complete by around age eight but treatment is possible into teen years. The target of vision screening is to identify amblyopia (poor vision due to abnormal visual experience in early life) which usually affects only one eye and is often asymptomatic. Most children with severe vision impairment in both eyes are detected in the first year of life either because of obvious difficulty with seeing or as part of the workup of another disorder.[1]

The World Health Organisation (WHO) states that the purpose of screening programs is to identify the population at risk in order to facilitate early treatment or intervention and thereby reduce disease incidence and/or mortality.[2] In this case, the aim of a vision screening program is to reduce prevalence of amblyopia and prevent permanent vision loss.

Screening should only be undertaken for important disorders for which there are acceptable, appropriate, and reliable tests and available effective treatments. The benefits of screening should outweigh the harms[1]

Wilson and Junger's principles of screening[3]	
1	The condition should be an important health problem
2	There should be an accepted treatment for patients with recognized disease
3	Facilities for diagnosis and treatment should be available
4	There should be recognizable latent or early symptomatic phase
5	There should be a suitable test or examination
6	The test should be acceptable to the population
7	The natural history of the condition, including development from latent to declared disease, should be adequately understood
8	There should be an agreed policy on whom to treat as patients
9	The cost of case-finding (including diagnosis and treatment of patients diagnosed)
10	Case-finding should be a continuous process and not a "once and for all" project

2.1 The condition should be an important health problem

Prevalence: Amblyopia is the commonest cause of vision loss in children and affects about 1.5-6% in various populations. The prevalence is similar across racial and ethnic pre-schoolers in the US[4]. Amblyopia (VA≤ 6/12) in 6 year old Australian children is rare (1.8%) with many children already under treatment, often because of underlying strabismus[5]; the prevalence was slightly higher in European Caucasian children (2.2%) than in East Asian children (1.7%) possibly due to a relatively lower prevalence of strabismus and hyperopia in the latter group[6]. Findings for the Sydney Myopia Study[1] indicated that 5% of 6-year-old children had an uncorrected refractive error in 1 or both eyes and that 4.4% of the 6-year-old sample were already wearing glasses. In an older adult Australian population the prevalence of unilateral amblyopia was 2.9 %[7] possibly reflecting an unscreened population.

Treatment for common causes of amblyopia (refractive errors and strabismus) can be commenced after referral by community optometrists or general/paediatric ophthalmologists. Children with organic conditions such as optic nerve disorders, cataract and glaucoma are referred urgently to a tertiary paediatric ophthalmology service for management.

2.1.1 Causes of Amblyopia

The common causes of amblyopia include refractive errors (particularly hypermetropia (long sightedness), anisometropia (unequal refractive errors), strabismus or a combination of these.[8] Rare causes include cataracts and other media opacities. Amblyopia is usually unilateral but can be bilateral (for example if there is bilateral astigmatism or hypermetropia).[9] Unilateral amblyopia is often asymptomatic because of compensation by the other eye.

Associated Disabilities: Amblyopia is an important health problem with an emerging literature on many previously unsuspected visual deficits including abnormal contour interaction, reduced contrast sensitivity, positional uncertainty, poor accommodation, abnormal eye movements and suppression.[10] Amblyopic children have reduced fine and gross motor skills[11] and read more slowly than controls.[12] In another study, significant differences were found in binocular maximum reading speed between children with micro strabismic amblyopia and controls[13]

Reduced visual acuity (bilateral) at age 4-5 years (school entry) is associated with reduced literacy, even after adjustment for demographic and socioeconomic factors. Literacy scores reduced with each line of vision reduction[14]

Patients with amblyopia are more likely to become visually disabled if their sound eye becomes visually impaired. The estimated lifetime risk of vision impairment is 1.2%. Vision loss in the only sound eye in an adult (eg from trauma) can significantly affect quality of life, including loss of employment. However, a study of the 1958 birth cohort in the UK found no functionally or clinically significant differences between people with or without amblyopia with respect to educational outcomes, behavioural difficulties, social maladjustment, unintended injuries (school, workplace, or road traffic accidents as driver), mortality, paid employment or occupational level.[15] A study of 3564 adults aged 49 years or older in the Blue Mountains Eye Study found an amblyopia prevalence of 3.2%. Amblyopia did not affect lifetime social class, but fewer people completed higher degrees (p=0.05). There was an increased risk of 5 year incident visual impairment in the better seeing eye, relative risk (RR) 2.7 (CI 1.6-4.6)[16]

Reduced vision in one eye can prevent employment in careers such as military, law enforcement, aviation, firefighting and driving heavy vehicles.

2.2 There should be an accepted treatment for patients with recognized disease.

2.2.1 Treatment of amblyopia:

The Amblyopia Treatment Studies (ATS) conducted over the last two decades by the Pediatric Eye Disease Investigator Group (PEDIG) have dramatically changed the treatment of amblyopia.[10,17] PEDIG studies have used randomised controlled trials with standardised visual acuity measurement techniques and cycloplegic refraction. ATS results were analysed on an 'intention to treat' basis. Amblyopia treatment now generally consists of a period of refractive correction, followed by part-time patching or atropine occlusion if refractive correction alone does not work[10,18,19]. In children < 7 years of age, approximately 75% will achieve resolution of the amblyopia. Treatment may need to continue for 6-12 months and tapering of treatment lowers the risk of recurrence[17]. Two comprehensive reviews of current treatment concepts are by Tailor et al and Holmes and Clarke. [9,20]

There has been a wave of enthusiasm for a variety of binocular treatments for amblyopia over the last decade or so. Despite initially promising results from case series, a recent Cochrane review found only one randomised controlled trial that demonstrated that binocular treatment is "likely comparable to that of conventional patching treatment". However, the authors stated it is not yet possible to draw robust conclusions regarding the sustained effectiveness of binocular treatment"[21]

2.2.2 Side effects of Treatment

One study reported parental difficulties with both patching and glasses wear as amblyopia treatments but no impact on the child's global well-being or behaviour either during or after treatment.[22] A later study reported that patching for amblyopia can reduce self-esteem in children while spectacle wear does not.[11]

2.2.3 Age at Treatment

A meta-analysis of 4 PEDIG Randomised Controlled Trials (RCT)of treatment for amblyopia found that there was a non-linear relationship between age and responsiveness to treatment. There was no difference in treatment outcomes in moderate amblyopia between children 3 to < 7 years of age and children 5 to < 7 years of age. For severe amblyopia, there was a non-statistically significant trend for the younger group to respond better than the older group. Children from 7 to <13 years of age were less responsive to treatment of both severe and moderate amblyopia that the younger age groups[23]

Preschool screening at 37 months vs no screening until age 7 ½ showed a prevalence of amblyopia of 1.1% in the treated group and 2.0% in the untreated group with improved treatment outcomes for children with amblyopia but the effect was small and disappeared when all children offered treatment were included.[24]

2.2.4 Refractive errors and Visual Performance

Children with uncorrected moderate/high hyperopia can be at risk of reading delay. A cluster RCT of children in grades 3-7 who received eyeglasses after failed vision screening showed improvement in reading scores over one year (especially girls, those in special education and those in lowest reading score quartile at presentation). A sustained benefit was not seen at two years, possibly due to a drop off in glasses wear.[25]

Bilateral refractive amblyopia (generally due to high hyperopia) responds to spectacle wear; the majority of children (74%) achieve 6/7.5 visual acuity within one year of spectacle wear[26] The VIP-HIP study showed that uncorrected hyperopic 4 and 5-year-olds (≥4.0D or ≥+3.0D to ≤ +6.0D showed deficits in early literacy and reduced near visual acuity and stereopsis compared with emmetropic controls [27]. Children with high hyperopia have much higher rates of amblyopia than emmetropes (51% ≥+5.00D, 34.5%≥ +3.50D).[28] What remains to be demonstrated by way of randomised controlled trials is whether early intervention (in asymptomatic children with normal acuity) by way of spectacles etc improves academic outcomes- this is necessary before recommending routine screening for refractive errors. This is an evolving area of research.

2.3 Facilities for diagnosis and treatment should be available

2.3.1 Outcomes After Amblyopia Screening

The ALSPAC Study (based in Bristol, UK) reported the results of a randomised trial of intensive screening for amblyopia at 8,12,18,25,31 and 37 months versus a control group screened for amblyopia at 37 months only. The intensive group showed better acuity in the amblyopic eye and a lower prevalence of amblyopia at 7.5 years of age[29] A subsequent paper demonstrated that screening at 37 months alone had a better outcome at 7.5 years than no screening (40% reduction in amblyopia) but the therapeutic effect was small and disappeared when analysis was on an intention to treat basis.[24]

Two landmark studies, have shown a reduction in amblyopia prevalence after screening when compared to controls: In an Israeli study, screening in infancy lowered the prevalence from 2.6% to 1.0%[30] and in a Swedish study the prevalence of amblyopia (VA≤ 6/12) was lowered from 2% to 0.2%.[31]

A 2018 Cochrane review evaluating vision screening for correctable visual acuity deficits in school-age children and adolescents[32] concluded that vision screening plus provision of free spectacles improves the number of children who have and wear the spectacles they need compared with providing a prescription only. There was only low certainty evidence of better educational outcomes.

A Canadian study found that of children referred after a failed screening (127/509) who then underwent a detailed examination, 58% were diagnosed with more than 1 eye condition – refractive error (76%), amblyopia (43%), strabismus (16%) and anisometropia (13%). However, more than 70% of study participants were from African American and Hispanic backgrounds and may be considered disadvantaged.[33]

PEDIG has recently published an RCT that showed that children of school age screened for vision problems and prescribed glasses showed improved academic performance at 1 year post intervention but this was not sustained at 2 years, possibly due to reduced compliance or a change in refractive errors.[34]

A New Zealand study found that using acuity worse than 6/9 as a referral criterion produced an unacceptably low positive predictive value (PPV-31%) of preschool screening programs to detect actual and reduced visual acuity and that relaxing the criterion to less than 6/12 improved the PPV without affecting the high negative predictive value (NPV).[35]

2.2.6 Who should screen?

It is recommended that screening be undertaken by screeners without a vested (eg financial) interest in outcome so as to avoid a conflict of interest. For this reason, neither ophthalmologists nor optometrists should act in a primary screening role.[36] In the UK this is undertaken by orthoptists as per NHS recommendation (https://view-health-screening-recommendations.service.gov.uk/vision-defects- accessed 21 Nov 2022). The NSW StEPS program uses lay screeners and nurses for primary screening while orthoptists perform secondary screening. The Qld prep screening program uses child health nurses as primary screeners. Lay screeners (suitably trained) have been found to have comparable accuracy to professional screeners.[37]

A UK study found that orthoptic led screening services (where the actual screening is delivered by "well-trained and monitored screeners" is of similar quality to orthoptist screening[38]

2.4. There should be recognizable latent or early symptomatic phase

Because amblyopia is usually unilateral, it is often asymptomatic in childhood and may not be diagnosed until late in childhood when the results of treatment are less satisfactory. Amblyopia is best detected by measuring visual acuity. Children with bilateral poor vision are usually symptomatic or detected by surveillance because of known risk factors (eg family history, antenatal screening).[1] Most children with obvious strabismus have been treated before the pre-school period.[5]

2.5 There should be a suitable test or examination

Lea and linear HOTV tests appear comparable.[39] for testing of 3-5 year-olds. Visual acuity normal ranges need to be assessed for each screening acuity test because there can be up to a line difference in acuity when testing single letter optotypes with confusion bars (surrounds) or linear LogMAR charts.[40] Isolated single letter testing has an unacceptably low sensitivity for detecting amblyopia when compared to a LogMAR based test.[41]

It is generally accepted that direct testing of visual acuity is essential to vision screening. Testing for stereopsis and ocular motility is not generally supported: Toufeeq and Oram (2014) reported on the costs of a comprehensive screening exam by orthoptists including VA, cover test, ocular motility, 20 pd BO test and Frisby stereo test. The cost/child screened was approximately three times the cost where visual acuity alone was tested with little apparent improvement in the detection of amblyopia[42]. In the accompanying editorial Solebo and Rahi concluded that " there is at present *no evidence to justify the inclusion of assessments of visual*

function beyond acuity (their italics) , such as tests for strabismus, refractive error or stereopsis in a screening program"[43]

Photoscreeners detect refractive errors and strabismus but do not measure visual acuity so, when used alone, they are more useful in children under three who are not generally co-operative with visual acuity testing. When used in combination with visual acuity testing, the combination has a higher positive predictive value for the detection of amblyopia than either test alone[44,45] . Most children with apparently normal acuity who fail photo screening have minor refractive errors while the finding of abnormal acuity in the presence of a normal photoscreen can indicate not only possible amblyopia but also potential sight (and even life threatening) conditions such as optic nerve disease and intracranial disease[44]

2.6 The test should be acceptable to the population

Screening for amblyopia is non-invasive; testing for visual acuity is part of routine clinical practice. Amblyopia screening is highly acceptable to the community. Screening rates for community screening (av 65% of eligible children) were reported to be generally lower than school entry (high 90s %) in the UK [42]. However, Australian screening rates for the eligible population are more comparable and are reported as 86% for StEPS (pre-schoolers) (2019 data; NSW Ministry of Health 2022) and 93.6% for the Qld Primary School Nurse Program.[45]

2.7 The natural history of the condition, including development from latent to declared disease, should be adequately understood.

There are limited data on untreated amblyopia but there is evidence that amblyopic eyes are at risk of further deterioration if left untreated.[46] A study of 15 year-old adolescents treated for amblyopia in childhood showed that the treatment effect is maintained.[47]

2.8 There should be an agreed policy on whom to treat as patients.

In clinical practice, children who fail vision screening and are true positive cases are all offered treatment so the screening criteria basically identify those children who require treatment.

2.9 The cost of case-finding (including diagnosis and treatment of patients diagnosed)

2.9.1 Cost Effectiveness of Amblyopia Treatment

One study found amblyopia treatment to be highly cost-effective[48] but a systematic review found that the cost effectiveness of amblyopia screening depended on the long term utility effects of unilateral vision loss which were not well studied[49] A 2018 review of the NSW StEPS programme found that (preschool) amblyopia screening was cost effective.[50].

2.10. Case-finding should be a continuous process and not a "once and for all" project

Generally, the screening should occur at one age level or stage in the education process where there is total coverage of the population at risk. Follow up of children who miss the primary screening should occur. Because the risk factors for amblyopia occur in infancy or early childhood, screening at only one point in time should detect all of the affected population. Vision loss in middle/late childhood is almost always due to the development of myopia; organic causes of vision loss in these children is vanishingly small (eg brain tumours), is often

symptomatic (or the child is old enough to notice a decrease in vision) and does not justify screening for its own sake.

After screening, a clear referral pathway is necessary. Across most of NSW, there are dedicated catch up StEPs clinics for children who have missed the primary screening. In Qld, referral after screening[45] is for VA 6/9-2 -6/12 is usually to community optometrists or preferably to Qld Children's Hospital 'aligned' optometrists[51]. For VA 6/18-6/30 an intermediate priority referral is made and 6/18 for children with VA 6/30-1 are referral is generally made to paediatric ophthalmologists where they are available.

3. When to Screen: Recommended age for screening

The UK National Screening Committee 2019 review (https://view-health-screening-recommendations.service.gov.uk/vision-defects- accessed 21 Nov 2022) recommended that "screening of children's eyes should continue to be offered to all children aged 4 to 5 years. This service should be organised and led by specialists (orthoptists)".

In 2016, the American Academy of Pediatrics, American Association for Pediatric Ophthalmology and Strabismus, American Academy of Certified Orthoptists, and American Academy of Ophthalmology released a joint clinical report recommending vision screening from birth and at all routine health (paediatrician) visits.[52]

The US Preventive Services Taskforce (USPSTF) conducted a systemic review of literature until June 2017.[53] The USPSTF review had five key questions which are briefly addressed below:

1. Benefits of screening- evidence graded as low.
2. Accuracy of screening tests- evidence graded as low.
3. Harms of screening- evidence graded as low for bullying, moderate for false positive rates, insufficient for other harms.
4. Benefits of treatment- evidence graded as moderate for improved visual acuity.
5. Harms of treatment-evidence graded as low.

Based on this evidence, the USPSTF recommended vision screening in all children aged 3-5 because of "high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial."[54]

3.1 Measuring the success of childhood vision screening programs

A UK evidence review[55] found that that there was no RCT evidence that treatment earlier or later than the age of 4-5 years produced better outcomes but it cited a paper reporting that treatment after age 5 possibly produces in poorer outcomes in children with moderate and severe amblyopia[23] and is unlikely to confer benefit in terms of increased reliability of testing.[55] The review was updated in 2019 with no change in the recommendations of screening at ages 4-5 in an orthoptist led service[56]. Screening of children less than four years of age is associated with an increased risk of false positive results[57] In a RCT of 4-5 year-old children detected by preschool screening, which compared full treatment with glasses and patching to glasses only or an untreated control group, there was little benefit for children with mild amblyopia (6/9-6/12) but for those with moderate acuity loss (6/18-6/36), there was a treatment effect of 1-2 lines of Snellen acuity but there was no negative effect from delaying treatment for up to a year until

age 5.[58] An earlier European study cited practical reasons relating to linear acuity chart and adequate treatment as reasons for commencing treatment at 5 yrs[59].

3.2 Best practice in children's vision screening in Australia

Current guidelines in Australia are developed through state government initiatives. In Australia, vision screening is mostly conducted at school entry, 5 to 6 years of age however in some states screening occurs before school starts. For example, NSW Health runs the StEPS program (State-wide Eyesight Pre-schooler Screening) which offers all 4-year-old children free vision screening before school begins through the local health district preschools and childcare centres. Opt-in consent forms are needed to participate and alternative options for vision assessment are available at respective NSW Health Child and Family Health services and GP practices. Whilst this program is highly successful, screening at the preschool level can lead to children not in childcare missing out on screening. Follow up clinics for children missed is part of the StEPs program.

Nationally coordinated programs ensure the majority of children are captured. In the UK, all children are screened in the first year of entering primary school with visual acuity assessment and referral through the national health system. The age of screening ranges from 4-5 years as all children must enter reception (kindergarten) by the time they turn 5 in August of the school year. This is one of the gold standard models of screening as the timing of the discovery of amblyopia ensures the ability to treat for several years before expected visual maturation.[9]

However, unlike in the UK, in NSW, parents can choose what age their child enters the education system with some children not commencing until age six. Screening for amblyopia at age five to six occurs in Queensland, coinciding with prep entry. Most of the evidence of effectiveness of screening recommends this take place at ages 3-5 but there is little published evidence on screening from age 5 upwards.

4. Recommendations

- Based on the evidence, the College supports vision screening for amblyopia in early childhood as a worthwhile objective.
- Screening should involve a valid test of visual acuity such crowded optotypes or a linear LogMar chart.
- Photoscreening may confer an additional benefit but is not essential.
- More complex testing, e.g. Stereopsis testing and ocular motility testing do not appear to offer a significant benefit but may substantially increase cost.
- The optimal age for screening which balances age of onset of the common risk factors, ease of testing, availability of most of the population at risk and response to treatment would appear to be about 5 years of age (with some regional variation)

- separate assessment and diagnosis of children at high risk of vision disorders such as:
    - children who are prevented from, or delayed in, accessing necessary health information and health services[60]
    - children from remote indigenous populations
    - children with multiple disabilities
    - children born prematurely.

The exception is when programs targeting these high-risk groups are already built into the service model as per the StEPS program in NSW.

- There must be established pathways for referral for children who fail screening- with follow up to ensure attendance.
- There must be an audit of outcomes of screening and follow up.

5. Record of amendments to this document

Page	Details of Amendment	Date amended
Entire document	Created	April 2023

6. References

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