

# **An Evaluation of Vision Screening Protocols in Young Children**

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the degree of

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under the supervision of Professor Kathryn Rose and  
Dr Amanda French

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## **Certificate of Original Authorship**

I, Mythili Ilango declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Graduate School of Health at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution.

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## **Thesis Abstract**

### Background and Aims

There is a growing body of evidence supporting vision screening for preschool children and a recent evaluation of the New South Wales (NSW) Statewide Eyesight Preschooler Screening (StEPS) program found the program to be highly appropriate and cost-effective. However, there are no universally accepted protocols for vision screening, either nationally or internationally. In this context, this thesis aimed to address several questions related to ideal approaches to childhood vision screening. This included, to determine if visual acuity screening is more accurate at school age compared to preschool age, the comparability of referral rates and appropriateness of referral thresholds using the Sheridan Gardiner and HOTV logMAR charts, and whether including additional tests in screening protocols would improve detection of conditions. In addition, this thesis aimed to define the ocular conditions that may reduce vision at different ages and whether repeat screening may be required later in childhood. Finally, this thesis examined the impact of cycloplegia and refraction method for measurement of refractive errors in children and the natural history of hyperopic refractive errors to examine the need for detection and prescription of refractive correction.

### Methodology

To answer the aims of this thesis, we have drawn on a number of relevant data sources. Existing datasets from the series of population-based studies of eye health in metropolitan Sydney children, the Sydney Childhood Eye Disease Studies that included, the Sydney Paediatric Eye Disease Study (SPEDS), the Sydney Myopia Study (SMS) and the 5-6 year follow-up Sydney Adolescent and Vascular Eye Study (SAVES) were utilised for analysis. These studies collectively examined a total of 7266 children between 6 months and 17 years of age. All children had a comprehensive ocular examination including, age-appropriate visual acuity testing, orthoptic assessment and cycloplegic autorefraction.

As part of the main project of this thesis, the Preschool Vision Screening Study (PVSS), 94 four year old children were recruited through StEPS. Vision screening was performed in preschool and childcare settings according to StEPS protocols using both the Sheridan



Gardiner visual acuity chart and the HOTV logMAR chart, followed by an additional orthoptic examination. The StEPS program referral criteria was used to refer children who did not pass screening. One month post-screening parents or guardians of children who were referred from screening were followed-up to determine the outcome of referral and barriers related to successful follow-up.

## Results

This thesis has provided additional evidence that four years of age is ideal for vision screening, when amblyopia and early refractive errors are common causes of reduced vision and as intervention is time-sensitive to optimise treatment outcomes, and to address reduced vision prior to school entry. In addition, accuracy of vision screening was not compromised at preschool age in comparison to early school age screening, with visual acuity having a high sensitivity and specificity for amblyopia and myopic refractive errors. At 12 years of age, there was a substantial increase in the prevalence of myopia and this remained a significant cause of reduced vision in older children. Targeted school screening for those at risk of developing myopia or education for children and parents to increase detection and reporting of symptoms would be an appropriate and cost-effective approach to increasing myopia detection at this age.

Visual acuity testing had considerably lower sensitivity for the detection of hyperopic refractive errors in preschool children, suggesting that current vision screening protocols may not successfully detect this refractive error. There was a hyperopic mean refraction in the 6-12 month age group in Sydney that subsequently decreased through childhood. Interestingly, this analysis revealed a more myopic mean refraction in children with darker irides, likely related to lower efficacy of cycloplegia. This may result in under-detection of hyperopia in this population. There has been debate about the necessity of refractive correction for hyperopia in childhood and whether spectacle correction may interrupt normal emmetropisation to reduce hyperopia. However, data in this thesis has shown that children who are hyperopic, particularly those with high hyperopia, often remained significantly hyperopic into adolescence and that refractive correction did not impair

reduction of hyperopia through emmetropisation. Thus, there is likely benefit to both the detection and prescription of refractive correction for children with significant hyperopia.

The StEPS program has recently transitioned from the Sheridan Gardiner visual acuity chart to the gold-standard HOTV logMAR chart. Comparison of these two tests to determine the impact on referral rates and whether current referral criteria were likely appropriate was conducted. Visual acuity was considerably higher using the HOTV logMAR than found with the Sheridan Gardiner chart, indicating that referral rates in StEPS are likely to reduce after the transition to the logMAR chart. The current referral criteria of visual acuity worse than 6/9 is even more suitable now since the mean visual acuity of preschool children was 6/7.5 using the HOTV logMAR. However, it is recommended that an additional referral criterion of  $\geq 2$  line visual acuity difference between eyes be considered. The inclusion of additional screening tests did not significantly increase detection of childhood ocular conditions.

### Conclusion

Overall, the series of chapters presented in this thesis have provided further evidence of the most effective protocols for vision screening in childhood including, that four years is the optimal target age for vision screening and that a referral threshold of 6/9 is appropriate when using HOTV logMAR for preschool children. The findings in this thesis further indicate that repeat screening in the early school years would not be valuable but, targeted screening or education in adolescence may support the detection and management of myopia. Finally, this thesis has shown the challenges of detecting hyperopia using visual acuity screening and as correction does not impact normal emmetropisation, detection of hyperopia and its correction is likely to have benefit for children.

## **Publications and Presentations**

### **Published Peer Reviewed Abstracts:**

Ilango M, French AN, Rose KA. The Prevalence and Causes of Vision Impairment in Childhood. 2020; Australian Orthoptic Journal; 52.

Ilango M, French AN, Rose KA. A comparison of the HOTV LogMAR versus Sheridan Gardiner Chart for preschool vision screening: StEPS Program. 2019; Australian Orthoptic Journal; 51.

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Ilango M, French AN, Rose KA. What is the ideal visual acuity cut-off for detecting ocular conditions in preschool children? 2018; Australian Orthoptic Journal; 50.

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Ilango M, French AN, Rose KA. Change in Refraction and Biometry of Children with Hyperopia. 2018; ARVO, The Association for Research in Vision and Ophthalmology Conference, Honolulu, Hawaii.

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## Glossary of Abbreviations

<b>Abbreviation</b>	<b>Full term</b>
ABS	Australian Bureau of Statistics
AL	Axial Length
ANOVA	Analysis of Variance
ATS	Amblyopia Treatment Study
BCVA	Best Corrected Visual Acuity
BPEDS	Baltimore Paediatric Eye Disease Study
BSV	Binocular Single Vision
CCES	Community Children's Eye Service
CEHW	Community Eye-Health Workers
CI	Confidence Interval
CLEERE	Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error Study
CR	Corneal Radius
D	Dioptres
DC	Dioptres Cylinder
DS	Dioptres Sphere
ETDRS	Early Treatment of Diabetic Retinopathy Study
EVA	Electronic Visual Acuity



GOS	General Optometry Service
IOD	Intraocular difference
IOL	Intraocular Lens
LE	Left Eye
Log MAR	Logarithm of the minimum angle of resolution
MEPDS	Multi-ethnic Paediatric Eye Disease Study
NHMRC	National Health and Medical Research Council
NSW	New South Wales
OCT	Optical Coherence Tomography
OMs	Ocular Movements
OR	Odds Ratio
PEDIG	Paediatric Eye Disease Study Group
PVSS	Preschool Vision Screening Study
RAF	Royal Air Force
RAPD	Relative Afferent Pupillary Defect
RE	Right Eye
RESC	Refractive Error Study in Children Study
SAVES	Sydney Adolescent Vascular Eye Study
SCES	Sydney Childhood Eye Studies
SER	Spherical Equivalent Refraction

SES	Socioeconomic Status
SG	Sheridan Gardiner
SMS	Sydney Myopia Study
SPEDS	Sydney Paediatric Eye Disease Study
SPSS	Statistical Package for the Social Sciences
STARS	Strabismus, Amblyopia and Refractive Error Study
STEPS	Statewide Eyesight Preschooler Screening
UK	United Kingdom
USPSTF	United States Preventative Services Task Force
UTS	University of Technology Sydney
VA	Visual Acuity
VIP	Vision in Preschoolers study group
WHO	World Health Organisation